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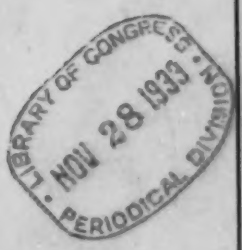

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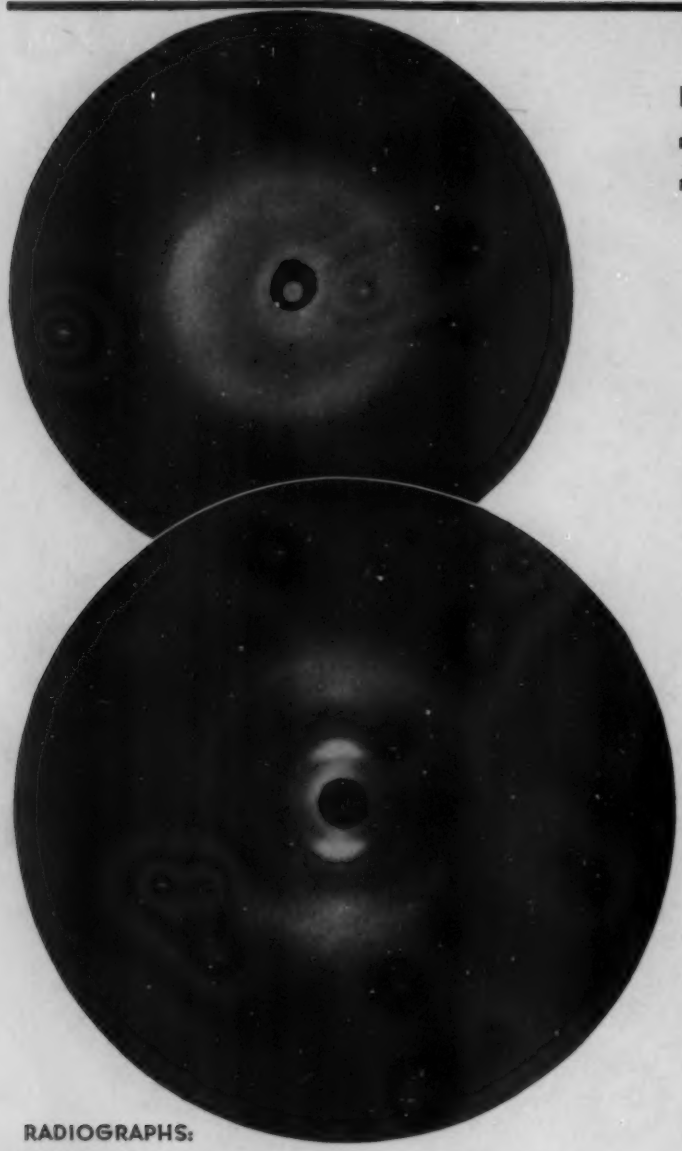

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 42 OCTOBER, 1939 No. 4

EXAMINATION OF THE LARYNX AND ADJACENT STRUCTURES WITH INTRAPHARYNGEAL FILMS

By ADOLPH HARTUNG, M.D., *and* J. W. GROSSMAN, M.D.

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ALTHOUGH the various structures of the neck can be satisfactorily studied and demonstrated by roentgenoscopic examination and by roentgenograms made in the lateral direction, sagittal views as ordinarily obtained give little information relative to them because practically all details are obscured by the superposed spine. Réthi[1] in 1912 and again in 1914[2] described a procedure whereby these conflicting shadows could be eliminated by making anteroposterior views with a film placed within the pharynx. In spite of his convincing demonstration of its value, the method apparently found little practical application, judging from the lack of reference to it in the literature. Recently, interest in it has been revived, at least in Europe, and excellent articles on it have been published by Waldapfel,[3] Ledoux-Lebard, Garcia-Calderon and Djian[4] and Ciurlo and Oliveri.[5] Lack of such articles in the English literature would seem to justify publication of our experience with it.

The technique of examination used by us was practically identical with that of previous investigators. When we began this work no commercial films adapted for this study were available to us. We cut ordinary roentgen films to approximately the size and shape advocated by Waldapfel, shown in Figure 3 *A*. These were backed

FIG. 1. Lateral roentgenogram of the neck showing intrapharyngeal film (wrapped in lead foil for purposes of illustration) in position.

by a layer of lead foil for producing added contrast and wrapped in black light-proof paper. The whole was covered with paraffined paper to protect it from moisture and from the vaseline which was applied immediately before insertion of the film, which have answered all requirements and proved to be more satisfactory than our homemade ones. Figure 1 shows the film (wrapped in lead foil for illustration purposes) *in situ*, as seen on a lateral neck roentgenogram.

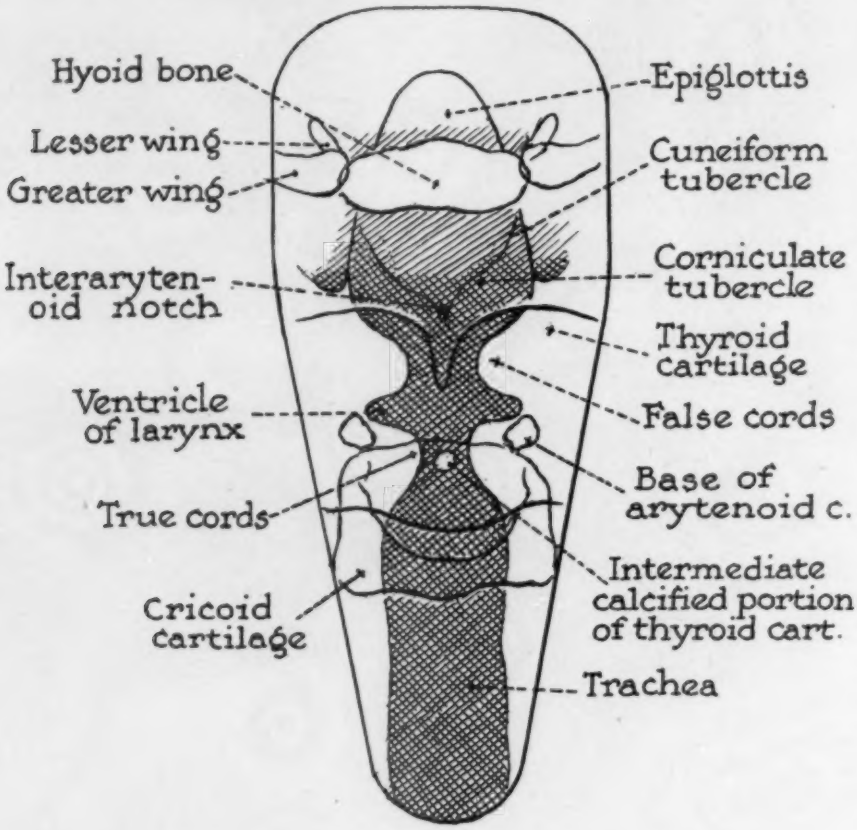


Fig. 2. Drawing illustrating normal anatomy as seen in view made with the central ray perpendicular to the film. Actual size and shape of "Pathé" film.

to facilitate its introduction. Sometimes smaller or differently shaped films were made to meet individual needs. The edges of the finished packet were made as smooth as possible to prevent trauma from its insertion. A pin hole was put in one corner of the film for identification of right and left sides and its position was uniform on all exposures. Recently French "Pathé" films, the actual size and shape of which are shown in Figure 2, have been supplied to us through the courtesy of Mr. R. Tarrant of the Eastman Kodak Company,

Insertion of the film is done in the roentgenographic room with the patient either in the sitting or supine position. Thorough anesthetization of the pharynx is essential. We used 2 per cent pontocaine for this purpose applied topically with spray and swab. Following this, the protruded tongue is held by the patient and the film held by a laryngeal forceps is guided over the dorsum of the tongue, past the epiglottis and into the pharynx.

Exposures are made with the patient in the supine position. The neck is slightly

hyperextended so as to bring the plane of the pharynx parallel to the table top. This may be facilitated by placing a small pillow under the patient's shoulders. The central ray is directed through the center of the thyroid cartilage either perpendicularly or obliquely to the film. The patient is directed to release the tongue, close the mouth and suspend respiration and deglutition during the time the exposure is being made. We have made no special effort to obtain films during different phases of respiration. During the entire procedure the film is held by the forceps which is so constructed that it may be rotated out of the field, without releasing its hold on the film. The factors of exposure used were: 45 kv. (peak), 12 ma-sec., 30-in. distance.

The intrapharyngeal roentgenogram permits of visualization of the following structures, shown in Figures 2 and 3: hyoid bone, epiglottis, valleculae, median glosso-epiglottic ligament, pyriform sinuses, ary-epiglottic folds, laryngeal vestibule, ventricular folds, vocal folds, ventricle of Morgagni, corniculate and cuneiform tubercles, interarytenoid notch, and trachea. Normally these structures either outline the air-filled passages in a symmetrical manner or are superimposed upon them. In the absence of calcium deposits in the laryngeal cartilages these cast no definite recognizable shadows. Ossification renders them visible and where this is extensive it may obliterate all details of the larynx (Fig. 3 *D*). Irregular calcium deposits may cause bizarre pictures difficult to interpret. The perpendicular view is the one we have generally used as it shows the various parts with least distortion. The oblique view is of special value where it is desired to show the base of the epiglottis and adjacent structures (Fig. 3 *C*).

Pathology of the various parts is revealed on intrapharyngeal films by abnormal size or configuration of the demonstrable structures and corresponding encroachment upon the air spaces. The changes present may indicate the size, shape, location or extent of a lesion and

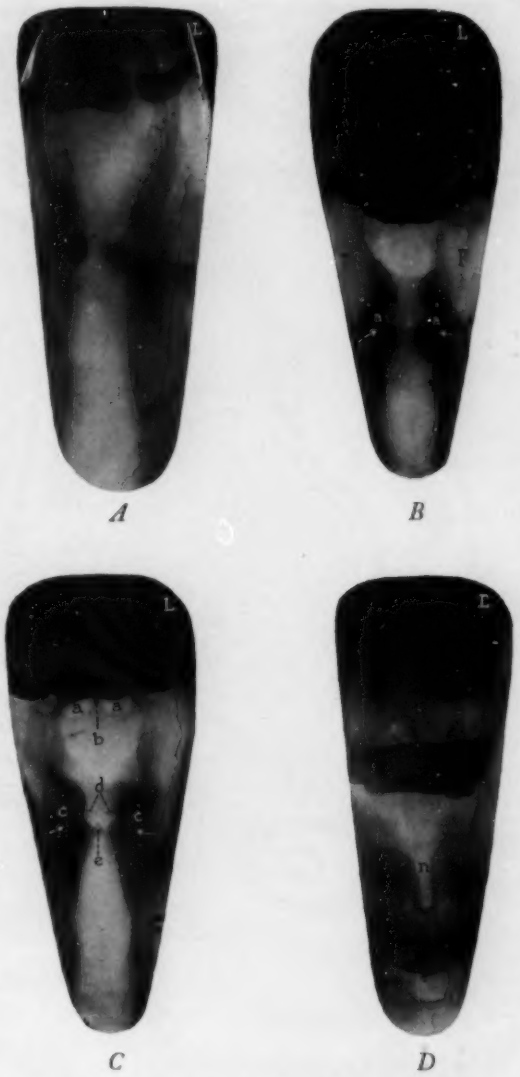


Fig. 3. *A*, white male, aged nineteen. Normal case. *B*, white female, aged twenty-three. Normal case, showing, *p*, pyriform sinuses, *a*, ossification in base of arytenoid cartilages and the crico-arytenoid articulation, arrows. *A* and *B* show the cords and ventricle in great detail due to a minimum of ossification in the laryngeal cartilages.

C, normal case. Oblique projection showing, *a*, valleculae; *b*, median glosso-epiglottic ligament; *c*, ossification in base of arytenoid cartilages; *d*, ossification of superior border of lamina of cricoid cartilage; *e*, intermediate calcified portion of thyroid cartilage. Arrows point to crico-arytenoid articulations.

D, white male, aged fifty-two. Normal case. Extensive ossification in thyroid and cricoid cartilages, obscuring details of cords and ventricle; *n*, thyroid notch.

A *B*

Fig. 4. Case 1. *A*, malignant tumor of epiglottis with extension into pharynx and larynx as seen on lateral roentgenogram of the neck. *B*, intrapharyngeal film showing tumor masses below epiglottis, with extension down the aryepiglottic folds into larynx.

its relation to or effect upon adjacent structures but hardly ever can definite conclusions be drawn from them relative to their exact nature. The findings on intrapharyngeal films similar to those on ordinary lateral ones depend in large part upon correlation with other methods of examination and clinical history for correct interpretation. Traumatic lesions in the presence of extensive ossification of the cartilages offer a favorable field for investigation by this method of examination.

In all of the articles published relating to the method, findings in both normal and pathological conditions are given consideration. Waldapfel[3] has presented by far the greatest variety of lesions illustrating the value of its use. The findings in cases of epiglottic tumors, postoperative laryngofissures, perichondritis of the cricoid cartilage, pneumatocele of the larynx, tuberculosis and carcinoma of the larynx, postoperative laryngeal resections, laryngeal diphtheria, laryngeal stenoses and pachyderma, are described and illustrated by him. The following 5 cases examined by us are cited in detail as fairly representative of examples of the information that may reasonably be expected and derived from intrapharyngeal films.

Case I (Figs. 4 *A* and *B*). T. N., male, white, aged forty-three. This patient had a biopsy-proven transitional cell carcinoma of the epiglottis, with regional glandular metastases, and extension into the adjacent pharyngeal and laryngeal structures. Treatment with roentgen rays was instituted and marked improvement resulted. About one year after the completion of the therapy the patient presented himself for a routine check-up examination. Indirect laryngoscopy revealed a recurrence of tumor tissue in the remains of the epiglottis with extension down the aryepiglottic folds and along the pharyngeal walls toward the larynx. A lateral roentgenogram of the neck showed deformity and irregular enlargement of the remains of the epiglottis with irregular densities extending down the aryepiglottic folds and along the pharyngeal walls, occluding the pharyngeal air space and encroaching on the vestibule of the larynx. There was also evidence of extension of the tumor tissue into the base of the tongue and into the anterior neck tissues. The thyroid and cricoid cartilages showed a moderate degree of ossification. The laryngeal ventricle was not visible. The intrapharyngeal film showed tumorous masses below the hyoid bone, extending down the aryepiglottic folds and occluding the pharyngeal air space. The true and false cords, and the laryngeal ventricle were visible and there was evidence of involvement of the left false cord by tumor tissue.

Case II (Figs. 5 *A* and *B*). L. C., female, white, aged forty-five. This woman had been in an automobile accident about three years before this study was made. She suffered trauma to the larynx, necessitating a tracheotomy two days later. The tube has remained in place since. Complete oto-rhino-laryngological examination including direct laryngoscopy re-

A

B

Fig. 5. Case II. *A*, lateral roentgenogram of the neck showing distortion of laryngeal cartilages and tracheotomy tube *in situ;* ventricle not visible. *B*, intrapharyngeal film showing sites of fractures through ossified portions of thyroid cartilage, and through lamina of cricoid cartilage. Tracheotomy tube *in situ*. Cords and ventricle not visible, probably due to traumatic obliteration.

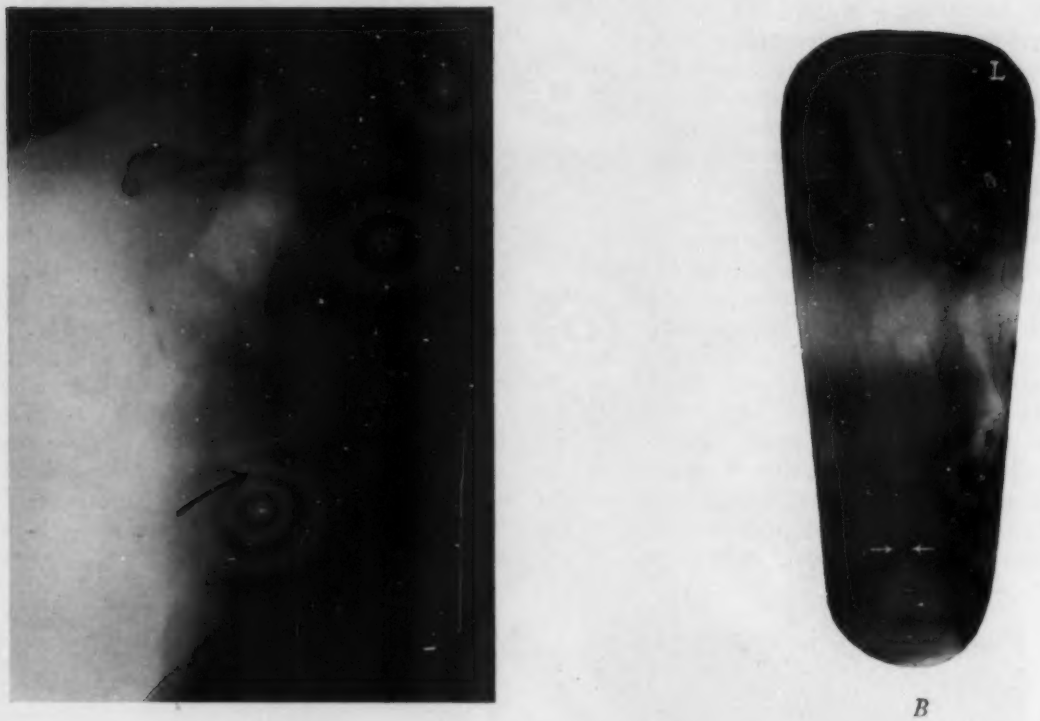


Fig. 6. Case III. *A*, lateral roentgenogram of the neck showing narrowing of trachea below cricoid cartilage, as indicated by arrows, and increase in width of prevertebral soft tissue shadow at this level. *B*, intrapharyngeal film showing subglottic stenosis of trachea as indicated by arrows.

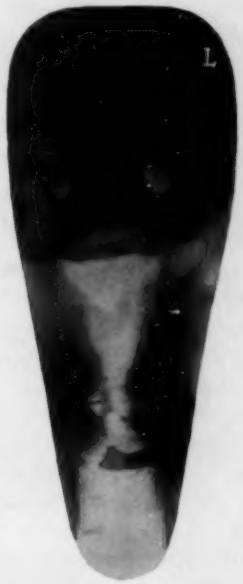
vealed the essential pathology to be a supraglottic stenosis of the upper air passages. The aryepiglottic folds were almost completely obliterated and the posterior part of the epiglottis was adjacent to the anterior part of the arytenoids. The arytenoids were fixed and the cords immobile on phonation. The lateral roentgenogram of the neck showed a tracheotomy tube *in situ*. The thyroid and cricoid cartilages were well ossified and appeared compressed from before backward and upward so that the superior horn of the thyroid cartilage was projected into the air-filled pharyngeal cavity posterior to the epiglottis. (As a rule in the normal the superior horn is superimposed on the prevertebral soft tissue shadow in the direct lateral exposure.) The cords and laryngeal ventricle were not seen. Hay[6] in his monograph on the roentgenography of the neck states that the laryngeal ventricle was visible in all of the female patients examined. Therefore its absence in this case was strongly suggestive of pathological obliteration. The trachea below the thyroid cartilage was patent. There were several irregularities of structure of the ossified portions of the thyroid and cricoid cartilages interpreted as old fractures. An intrapharyngeal film showed the tracheotomy tube in place, and irregularities of the thyroid and cricoid cartilages at the sites of old fractures. The ventricle and cords were not visible, even though the ossification in the laryngeal cartilages was insufficient to completely obscure them. This confirmed the laryngoscopic finding of post-traumatic laryngeal stenosis.

Case III (Figs. 6 *A* and *B*). M. P., female, white, aged fifty. This patient entered the clinic complaining of dyspnea and a choking sensation in the throat. As part of the workup, a complete oto-rhino-laryngological examination including direct laryngoscopy was performed. This showed a narrowing of the trachea below the level of the cricoid cartilage. The overlying mucosa was smooth and normal in appearance. A lateral neck roentgenogram showed some increase in the width of the prevertebral soft tissue shadow, posterior to the larynx and upper trachea, with narrowing of

the trachea below the level of the cricoid cartilage due to extrinsic pressure. The narrowing in the lateral direction, though apparent, was not marked. The intrapharyngeal film revealed a similar subglottic narrowing of the trachea. However, in the sagittal view this stenosis was quite marked. In both roentgen examinations, especially on the intrapharyngeal film, the area of stenosis appeared smooth and symmetrical. The exact diagnosis is as yet undetermined but from the clinical course and examinations, the process producing the stenosis is probably a benign one.

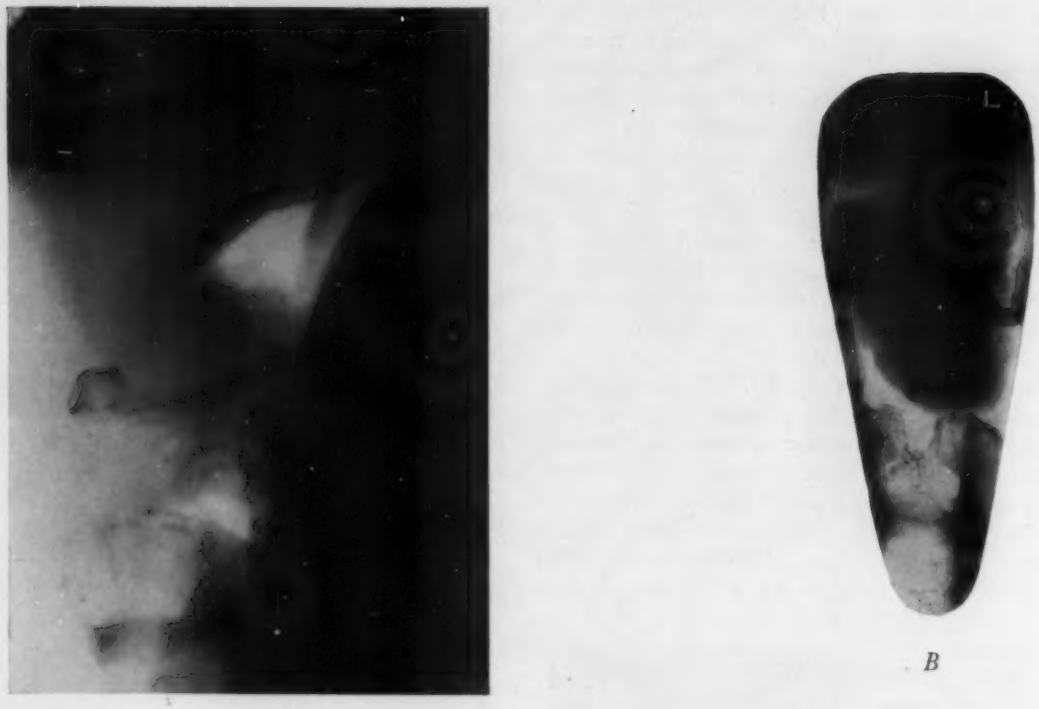
Case IV (Figs. 7 *A* and *B*). J. B., male, white, aged sixty-eight. This patient had a biopsy-proven hornifying squamous cell carcinoma of the larynx, which was treated with roentgen therapy. About two years after completion of the treatment the patient returned for a routine check-up examination. Indirect and direct laryngoscopy revealed no evidence of neoplastic tissue. The epiglottis appeared markedly deformed. This was interpreted as probably being due to post-irradiation sequelae. The remainder of the structures, including the vocal cords, appeared approximately normal. A lateral roentgenogram of the neck revealed the deformity of the epiglottis and in addition showed an increase in width of the soft tissue shadow at the base of the epiglottis. The laryngeal ventricle was well visualized and appeared normal. Since laryngoscopic examination had not revealed a mass in the area in question, an intrapharyngeal film examination was made for additional information. This showed a markedly deformed epiglottis with a curled rolled-over border. The ends and ventricle were approximately normal. These findings substantiated the laryngoscopic findings. The apparent "mass" at the base of the epiglottis on the lateral roentgenogram of the neck was interpreted as probably being due to the deformity

A



B

Fig. 7. Case IV. *A*, lateral roentgenogram of the neck showing deformity of epiglottis and apparent mass at base of epiglottis, as indicated by arrow. *B*, intrapharyngeal film showing deformed epiglottis with a rolled over margin. The air space below the level of the hyoid bone is clear, and shows no evidence of a mass.



A *B*

Fig. 8. Case v. *A*, lateral roentgenogram of the neck showing tumor mass involving epiglottis, and extending toward larynx. *B*, intrapharyngeal film showing tumor mass involving epiglottis and filling vestibule of larynx. The tumor inferiorly does not involve the larynx.

of the epiglottis which had assumed a cup-shaped contour, simulating a mass in the lateral projection.

Case v (Figs. 8 *A* and *B*). J. R., male, white, aged sixty-one, entered the clinic complaining of sore throat, hoarseness and difficulty in swallowing. Examination, including indirect laryngoscopy, revealed a large irregular necrotic tumor mass involving the epiglottis and filling the valleculae. The mass encroached on the laryngeal vestibule so that all that remained of the air passage was a small canal to the right of the tumor. Visualization of the larynx proper was prevented by the position of the lesion. A lateral roentgenogram of the neck showed irregular enlargement of the epiglottis, with obliteration of the valleculae and extension of the tumor tissue into the base of the tongue. In this view the pharyngeal air space at the level of the neoplasm seemed occluded. The thyroid cartilage showed advanced ossification of the typical male type. The laryngeal ventricle was visible, but because of the ossification in the cartilages, its outlines were not clearly defined. Grossly, on this film the tumor seemed to extend inferiorly to the superior border of the thyroid cartilage. On the intrapharyngeal film the tumor was clearly outlined, almost occluding the laryngeal vestibule. Inferiorly it did not seem to involve the larynx as far as could be judged grossly. The air passage below the upper border of the thyroid cartilage was patent. The cords and laryngeal ventricle details were obscured by the ossified thyroid cartilage.

Our experience with the method would indicate that detailed and unobstructed views of the larynx and adjacent structures may be obtained with it. Not only does it eliminate superposition of the spine on the laryngeal structures, but close proximity of films to parts produces added clearness. It affords a means of recording anatomy and pathology of the parts in a projection otherwise impossible. In selected cases the added information to be obtained by it

may warrant exposing the patient to the potential danger of the necessary anesthetization and possible traumatism attendant upon insertion of the films even with the utmost care. It should certainly not be a routine procedure in connection with suspected pathology in this region and cannot replace such methods as direct or indirect laryngoscopy. As a supplemental procedure it may give valuable additional information and may serve as an important means of checking upon the progress or regress of a lesion. It should be combined with thorough roentgen study, including lateral neck film and roentgenoscopic study with and without contrast media. Although we have not found its use essential for diagnosis, it is a valuable adjunct in some cases.

We wish to express our appreciation to Professor F. Lederer, Head of the Department of Oto-Rhino-Laryngology, and to members of his department for the use of patients referred to us for this study and thank Drs. Paul Holinger, H. Brunner and L. Wachs for their assistance in conducting it.

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METHODS FOR DETERMINING PINEAL POSITION WITH ANALYSIS OF THEIR ERRORS*

By WALTER W. FRAY, M.D.
ROCHESTER, NEW YORK

THE errors resulting from the use of any of the methods (Fig. 1) used for determining pineal position may be either intrinsic to the method itself and therefore unavoidable, or be due to the lack of familiarity with the method, inexperience—the result of human fallibility. The nature of the intrinsic errors is essential to a proper understanding of the various methods and it is the purpose of the present paper to discuss the importance of both of these errors, outlining the precautions necessary for the avoidance of the latter.

Of greatest importance in the consideration of intrinsic errors is the error arising from the fact that displacement can only be detected when the displacement of the pineal has been sufficient to crowd it beyond the confines of the normal zone. A pineal located near the anterior border of the normal zone must be displaced 1 cm. posteriorly by a frontal tumor before its displacement can be recognized. A considerable mass may be present within a lobe of the brain without objective evidence of pineal displacement (Fig. 2).

A second intrinsic error common to all methods lies in the assumption that the center of calcification represents the center of the pineal mass. In using any method, it becomes necessary, if precise results are to be obtained, to place a point at the pineal which is believed to represent its center. If, however, calcification has begun at the periphery or eccentrically within the pineal, the center of the gland has not been located. In rapidly growing tumors of the pineal gland, the bulk of the tumor commonly contains no calcium, with the result that the center of the gland is never obtained for purposes of measurement.

In addition to these errors which are common to all methods the individual methods possess intrinsic errors characteristic of the method. The graphic method of Vastine and Kinney presents an error due to the non-proportional character of the graph. We have called attention to the fact that as skull length (anteroposterior diameter) increases, the normal band of the graphic method shifts posteriorly, with the result that in the longer skulls the pineal is quite frequently found lying anterior to the normal zone. This error produces a two-fold type of confusion: in normal cases conveying the impression that a tumor is present presumably located in posterior position of the brain and secondly, that a tumor is not present in true tumor cases in which a posterior shifting of the pineal has occurred from an anterior position in respect to the normal zone to one within the normal zone, presenting the features of a normal case though the actual posterior displacement produced by a tumor may exceed 1 cm. The correction of this error lies in shifting the normal band on the graph. This cannot be accomplished in the manner suggested by Dyke of moving the entire band forward 4 mm. for such a shift still fails to satisfy the requirements demanded for skulls of both long and short anteroposterior diameters. The moving of this band forward assists in the correction of the error found in the original Vastine and Kinney method for the skulls of the greater lengths, but it must be remembered that the Dyke modification moves the band forward to the same extent for skulls of the shorter anteroposterior diameters. The results obtained by the original Vastine

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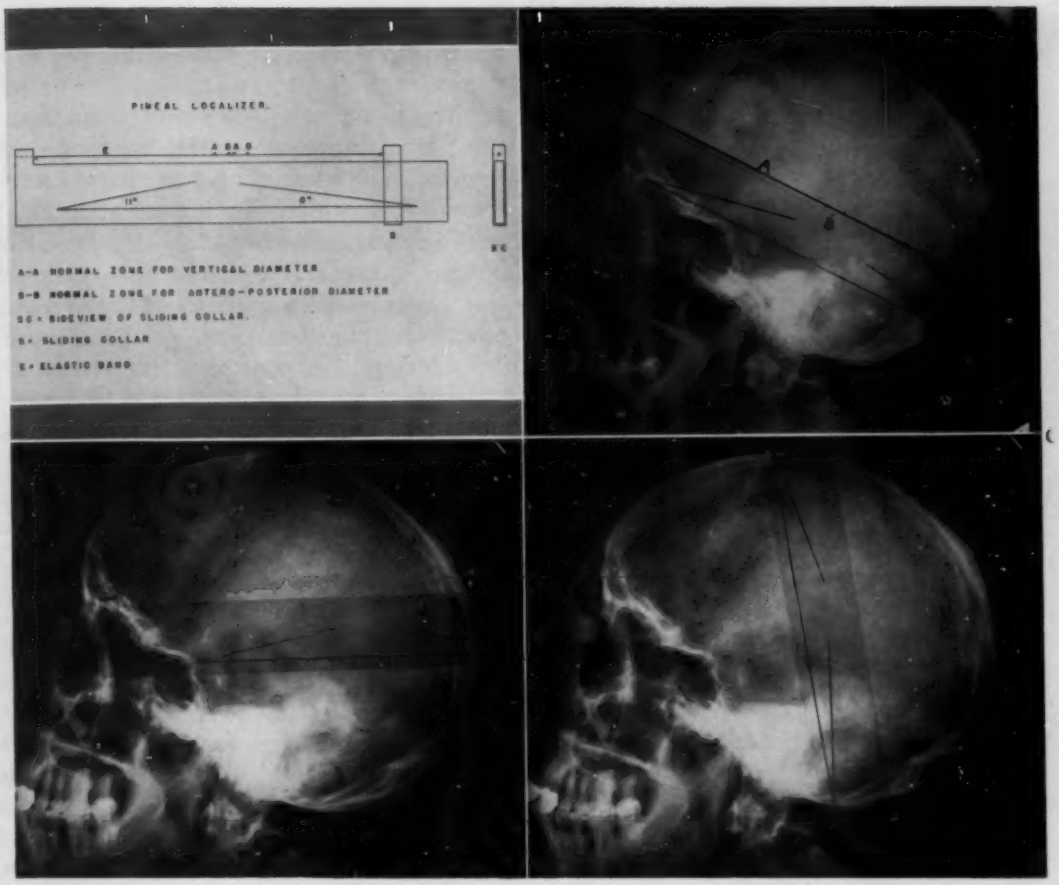

FIG. 1. The pineal localizer, a diagram of its construction, and illustrations demonstrating its use in the new proportional and cranioangle methods.

Upper left. The normal zones (proportional method) are defined on the elastic cord, *E*, the markers of the normal zone for the vertical diameter of skull being located 51 and 57 per cent of the length of the cord, while those for the anteroposterior diameter are located 55 and 60 per cent of the length of the cord.

Upper right. In applying the proportional method, the cord is stretched by sliding the collar until the beginning and end markers are located at the inner table of the frontal and occipital bones respectively. If the pineal, *B*, is in normal position, it should fall between the markers shown on the cord. For the vertical diameter, the cord is stretched so that the beginning marker is at the inner table of the vertex of the skull and the end marker coincides with the plane of the floor of the posterior fossa. The markers for the normal zone (vertical diameter of skull) have been removed purposely from the end to avoid confusion.

Lower left. For the cranioangle method, the two angles shown on the transparent guide are utilized. The vertex of the larger angle (11°) is placed at the base of the anterior clinoids and the long arm of the localizer passes through the lambda of the skull. A normal pineal should fall within the sides of the angle as shown (vertical diameter).

Lower right. For the anteroposterior diameter, the vertex of the smaller angle (8°) is placed at the opisthion (posterior margin of foramen magnum), the long arm defining the angle passing through the bregma. A normally placed pineal should fall within the lines forming the angle.

and Kinney method were quite reliable for these latter lengths of the skull and it is not desirable to shift this portion of the band. Shifting the normal zone 4 mm. forward was found in our series of normal cases to result in many of the cases presenting pineals posterior to the normal zone which fell within this zone by the original method.[2] If the band is modified so that the position of the graph remains approximately the same at the lower end of the graph (shorter skull lengths) and the

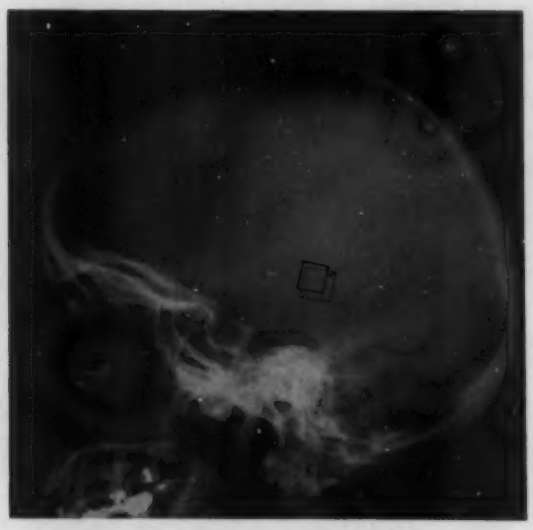

Fig. 2. Left frontal glioma. The patient presented the clinical signs of paresis of the right arm, a motor speech disorder and astereognosis. The film shows no localizing sign except for the position of the pineal. The pineal falls within the normal zone by the graphic method (broken lines) but lies posterior to the normal zone by the proportional method (solid lines). Note that the displacement has barely been sufficient to detect its presence by the proportional method and that the displacement must be even greater before it can be identified by the graphic method.

boundaries of the normal zone gradually shift forward to reach the upper end of the graph in approximately the position as suggested by Dyke, it will be found that the graph represents true proportional relationships, i.e. the distance of the pineal from the inner table of the frontal region is approximately 55 (anterior border of normal zone) to 60 per cent (posterior border) of the anteroposterior diameter of the skull. The changing relationships of the normal band of the original Vastine and Kinney method and Dyke's modification of this method are compared with our normal band in Figure 3 in which the position of the borders of the band is based on simple proportional relationships to skull length (50–55 per cent). This latter band forms the basis of our proportional method. We have simplified the procedure by mounting the normal band on an elastic cord which stretches uniformly throughout its length, thereby preserving proportional relationships. The mechanical device saves time and should facilitate the work in large clinics. If at hand, the measurements of the pineal are more apt to be made routinely. Many skull films showing displaced pineals have passed through the hands of the examiner without any determination having been made concerning a pineal shift, often because of the time element. Shortening the procedure by the use of the device should expedite routine work and by eliminating all mathematical deductions should lead to a large volume of work being done with a low incidence of error.

In addition to the differences described above, the graphic and proportional methods differ in the width of the normal zone. Neither the graphic method nor the Dyke modification of it makes any allowance in the width of the normal zone for the size of the skull. This width is the same for a skull of short anteroposterior diameter of 16 cm. as for a dolichocephalic skull of 23 cm. This indicates the pineal must be displaced not only absolutely but also a relatively greater distance (in respect to skull size) before the displacement may be detected. It is my belief that it is most

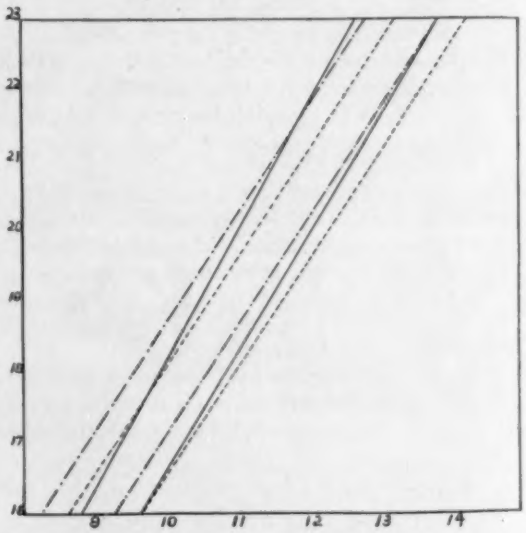

Fig. 3. Graph showing varying position of normal zones for pineal (graphic, broken lines; Dyke's modification, dot and dash lines; proportional, solid lines).

important to detect early or slight displacements and that this is more apt to be accomplished by the use of a method which confines the normal position to the smallest area consistent with accuracy (i.e. without placing an excessive number of the pineals of normal cases outside the normal zone). The proportional method narrows the normal zone down to a considerably smaller area and does this without significantly increasing the number of false normals.

Both the graphic and proportional methods possess a common error. They fail to make any allowance for variations in skull shape. The measurements are purely linear relating to the anteroposterior and vertical diameters of the skull. The points used on the calvarium are not anthropologic points which are employed so extensively in describing variations in skull shape by anthropologists. I have emphasized in a previous communication[2] that the incidence of error in pineal measurements is related to a crude skull index obtained by comparing the anteroposterior diameter of the skull with the vertical diameter. This index in spite of its crude character indicates the desirability of taking skull shape into consideration and finally leads us to seek an additional method which should be reliable in all types of cases but particularly valuable in skulls of unusual shapes.

The new cranioangle method utilizes for the most part well known peripheral anthropologic points of the skull as follows: the bregma, lambda and opisthion (posterior margin of foramen magnum). We have found that the utilization of these points together with the point at the base of the anterior clinoids by this method corrects many errors arising in interpreting the position of the pineal in skulls of either the dolichocephalic type or brachycephalic type, skulls showing varying degrees of oxycephaly (Fig. 4) or those presenting a very deep posterior fossa with an unusually long vertical diameter. There is, it should be added, no objection to the use of this method in making determinations in skulls of ordinary shape (mesocephalic), since in our series of control normals the accuracy of the cranioangle method (10 per cent error) is nearly as great as the proportional method (8 per cent), surpassing the original graphic method (16 per cent) for measurements made along the anteroposterior diameter and surpassing both of these methods for measurements (Table 1) made along the vertical diameter (graphic 11 per cent, proportional 7 per cent and cranioangle 2 per cent). It possesses a disadvantage in making the identification of all four points on the skull mandatory and in 4 per cent of our cases it was found that the lambda and bregma could not be identified with certainty in the lateral film of the skull. In these cases one must resort to the proportional method and for this reason our device provides for making determinations by both methods. This possesses the advantage of one method serving as a check upon the other.

Fig. 4. Oxycephalic skull without evidence of tumor. The very high vault and very short floor of the anterior fossa results in such marked disproportion of the skull that the proportional method (long broken lines) and the graphic method which closely corresponded with it fail to localize the pineal correctly (anterior to normal zone). The cranioangle method (solid lines) does not suffer the handicap of linear measurements. Note that the shortening of the floor of the anterior fossa is associated with a forward position of the bregma.

The preventable errors of both the graphic and proportional methods relate largely to improper selection of points. It must be remembered that the points most distal from the pineal on frontal and occipital bones (inner table) should be selected. In cases in which hyperostosis is present over the frontal area, the summits of these bony prominences should be avoided while, at the vertex of the skull, the craters of the pacchionian depressions should be similarly treated. At the cerebellar fossa the midline ridge between the lobes of the cerebellum should be avoided and the most posterior part of the cerebellar fossae obtained.

The opisthion (posterior border of the foramen magnum) may offer difficulties for the novice, but with increasing experience these should disappear. The floor of the posterior fossa may be traced forward to a point where the line of the floor can no longer be seen; beyond this point the lateral margins of the foramen magnum are visualized which at times may be seen as separate shadows if any lateral flexion of the head is present. The point where these two shadows, either superimposed or separate meet, represents the opisthion. Corroboration of this point may be obtained by tracing upward along the posterior aspect of the spinal canal at the upper cervical level. The canal broadens out considerably at its upper end and if one traces this posterior border upward to the undermost part of the skull, this projected point on the skull represents the opisthion. The remaining point used in the cranioangle method—the base of the anterior clinoids—should never offer difficulty on properly obtained films.

There is one remaining preventable error which relates to the proportional method. It is possible for the elasticity to be largely destroyed if the cord is maintained in a stretched condition for prolonged periods. This should be avoided, although during the past five years in which this localizer

Table I

COMPARISON OF METHODS FOR DETERMINING PINEAL DISPLACEMENT

Method	Accuracy (per cent) in Normal Series		Displacement in Cerebral Lobe Tumors (64)			Disadvantages
	Anteroposterior Diameter	Vertical Diameter	F	T	P	
Vastine and Kinney (graphic)	84	89	54	34	37	Requires measurements with rule and consultation with standard graphs. Errors due to (1) non-proportional character of graph producing errors in dolichocephalic skulls; (2) constant width of normal band; (3) variations in skull shape.
Dyke modification	84		81	48	63	Requires measurements with rule and consultation with standard graphs. Errors due to (1) non-proportional character of graph producing errors in brachycephalic skulls; (2) constant width of normal band; (3) variations in skull shape.
Proportional method	92	93	76	38	63	Errors due to variations in skull shape.
Cranioangle method	90	98	83	50	87	Difficulty in identification of points on skull in 4 per cent of cases.

has been used, the cord has been left stretched overnight with no demonstrable effect on its efficiency for pineal measurements. The original instrument devised by the writer is still in use with the same elastic cord placed on it in 1933. A check made on it during the writing of this manuscript showed no change in its reliability when comparison was made against test charts.

The testing of the instrument is advisable and is easily carried out if the test charts are at hand (Fig. 5). These charts are drawn to full scale and show the relation between the position of the normal band and the anteroposterior diameter (*A*) and the vertical diameter of the skull (*B*). The cord is stretched so that the end markers are at the ends of the polygram, at the top for an anteroposterior diameter of 16 cm. and the base of the polygram for one 22 cm. If the instrument has retained correct calibration, the normal band of the instrument will directly overlie the normal band indicated on the chart for any skull length from the shortest to the longest. The vertical diameter is checked in similar fashion for diameters ranging from 14–18 cm. If the instrument is found with the elastic cord in a stretched position, a check with these charts can be made very quickly with the assurance that if the checking shows no error the instrument can be returned to use. The more recent design of this instrument provides a slider which releases itself by the natural pull of the elastic cord. This type of construction will provide an instrument which should last for years.

The consistent and persistent use of such a device should accomplish a two-fold result—an easy rapid survey of all routine skull films for pineal position regardless of the original purpose of the examination and the detection of pineal shifts at an earlier period, in cases where definite symptoms are equivocal or entirely absent, thereby permitting early verification by ventriculography and early operative interference. If the massive tumors being explored today in neurosurgical clinics are to be avoided and the patient is to have a reasonable chance for operative removal, such steps are imperative.

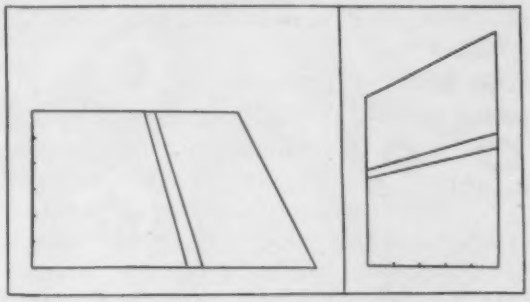

Fig. 5. Test charts for calibration of elastic cord for proportional method. The cord is stretched with end markers at lateral margins of trapezoid (left) for determining correct position of normal zone for anteroposterior diameter of skull and at top and bottom of the trapezoid (right) for the determination of the normal zone of the vertical diameter. If the instrument is properly calibrated, the markers for the normal zone will correspond with the sloping lines within the figures, independent of the degree of stretching.

CONCLUSIONS

(1) The graphic method presents a serious error in two types of cases (*a*) those of a long skull length with essentially normal skull shape and (*b*) those of normal or short skull length with abnormal skull shape.

(2) The first of these errors is due to the non-proportionality of the graph employed in this method, while the second is due to the fact that it relates essentially to linear relationship of the skull and employs no anthropologic points such as have proven of value in defining variations in skull shape by anthropometry.

(3) The proportional method corrects the first or most common type of error (type encountered in normally shaped skulls) by shifting the band forward for skulls of the longer anteroposterior diameter retaining much the same relationships as the graphic method for skulls of the shorter lengths, but an additional method is desirable for skulls of unusual or abnormal shape.

(4) The cranioangle method meets these latter requirements satisfactorily, being particularly useful in skulls with a deep posterior fossa, prominent occiput, high vault or oxycephaly, though it may and should be used in normal or mesocephalic skulls.

(5) None of these methods can be expected to yield perfect results, each having its errors, but a combination of the proportional and cranioangle methods incorporated in a single simple device shown and described in this paper will greatly reduce the errors, each method serving as a check upon the other.

(6) The ease and rapidity with which determinations for pineal position can be made by means of the mechanical device (pineal localizer) should permit its routine use in all skull work and routine determinations should result in the earlier detection of pineal shifts—earlier ventriculography in suspected cases and finally earlier craniotomy at a stage when intracranial masses may be more easily handled surgically.

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DISCUSSION

Dr. Arthur E. Childe, Montreal, Que. First may I express my appreciation for the privilege of being allowed to discuss Dr. Fray's most interesting paper. Anyone who has routinely measured the position of pineal calcification according to the method described by Vastine and Kinney or Dyke's modification realizes that altogether too many pineals which are not displaced do not fall into the normal zones. Conversely, pineals which are displaced by expanding lesions frequently fall into the normal zones, while later pneumography reveals a shift which it should have been possible to find in the original flat films. The importance of recognizing pineal shift as shown in lateral films becomes apparent when one remembers that many brain tumors are rapidly growing and pineal displacement may well be the only evidence of their presence. This applies particularly to glioblastoma multiforme and metastatic lesions, but it also applies to intracranial hemorrhages, acute abscesses, etc. It is true that recognition of a shift away from the midline as shown by anteroposterior or posteroanterior films is very important, but unfortunately comparatively few pineals can be recognized in this plane even with the best stereoscopic technique.

Dr. Fray's figures suggest that his methods of measurement are more accurate than those now commonly in use. Unfortunately, I have not had the opportunity to analyze the different methods in a large enough group of normal and abnormal cases to be able to confirm or disprove this statement, but have so far been rather favorably impressed with the ease and accuracy of the proportional method (elastic band). It seems to me that the cranioangle method, while entirely possible in some skulls, is difficult in rather more than 4 per cent, as the lambda and bregma are often very hard to locate accurately.

I would like to suggest that a number of us go home and pick out two moderately large groups of skulls, showing pineal calcifications. The first should be normals as shown by subsequent encephalography. The second should be cases of brain tumor proven by operation or autopsy. These two groups should be thoroughly shuffled and then the pineal position measured by graphic, proportional and cranioangle methods. It will mean a good deal of work but when the final analyses by the different examiners are available we should be able to answer the question of the reliability of the different methods with considerable accuracy.

Unfortunately there are many small brain tumors which are even more important to recognize than the larger, often inoperable

variety, which do not shift the pineal from its normal zone, narrow though that be. Eccentric calcification is another pitfall which appears from time to time and is very difficult to avoid. The possibility of determining the presence or absence of an expanding intracranial lesion from the position of calcification within the pineal will never reach 100 per cent but possibly we now have methods at our disposal which are more accurate than those formerly in use.

Dr. Cornelius G. Dyke, New York City. For some time I have been concerned with the diagnosis of cranial lesions and have been very much interested in the two methods that Dr. Fray has suggested be used for determining the position of the pineal body.

The rubber cord or elastic idea that has been discussed this morning is based on the Vastine and Kinney method of localizing the pineal body. Previous to Dr. Fray's work it was suggested by Dr. John D. Camp. Dr. Camp did not use a rubber cord; he used a coiled spring and exhibited it at the American Congress of Radiology in 1933. The principle, whether using rubber or a spring, is the same. Camp has not to date published a description of his instrument for localizing the pineal body.

Of the two methods that Dr. Fray has mentioned here this morning, it seems to me that the cranioangle method is the less satisfactory. The manipulations cannot be done as quickly as they can with the elastic cord or proportional method, and in a number of cases it is impossible to locate the bregma and the lambda in the roentgenogram.

I have had a few cases in which there was a definite tumor in the frontal region and the pineal was displaced posteriorly as much as 5 or 6 mm. with the Vastine-Kinney charts, but I found with the proportional rubber cord method that the pineal body fell within the normal zone. I think it should be emphasized that there is a certain amount of error with any method; that pineals will be in the normal zone with one method while they are displaced according to the standards of another method. As Dr. Fray and Dr. Childe have both said, none of these methods is going to approach absolute perfection. We will have correct results in about 85 to 90 per cent of the cases and I think that is very good.

What I have been doing in particular the past few years is to note the shape of the skull. If there is a very prominent occiput, this must be taken into consideration in the interpretation as to whether or not the pineal gland is displaced. Naturally such a skull is going to cause the pineal gland to move forward either in the normal zone or anterior to it. If there is a long anterior or middle fossa it will do just the reverse, i.e., the pineal would tend to be posterior to the normal zone. Obviously then it is important to note the shape of the skull when the position of the pineal gland is being determined.

At best, the methods discussed strongly suggest a tumor when the pineal body is displaced according to these charts, but the method is not perfect or absolute evidence of the presence of a tumor.

OSTEOCHONDROSIS DEFORMANS TIBIAE

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CONSIDERABLE confusion still exists concerning a variety of affections involving the growing ends of long bones. Blount[1] has recently called attention to one group of these which he cites as "Tibia vara or osteochondrosis deformans tibiae." Even though his theme may fail to adequately define the conditions presented there can be no doubt that it has advanced our understanding of this group of affections.

FIG. 1. Case 1. W. R., aged one year and five months.

Within the past year 2 cases showing changes simulating although not exactly typical of his infantile type of tibia vara have come under my care. On reviewing hospital records 2 cases showing characteristic changes of his adolescent type were found. It is with the feeling that more consideration should be given these conditions that the 4 cases are here presented.

THE INFANTILE TYPE

CASE I.* W. R. (Fig. 1), a white boy, aged one year and five months, was seen in the Pediatrics Dispensary on October 11, 1937, because of gradually increasing bowlegs. He began to walk at the age of eleven months at which time the parents claim his legs were not bowed.

He was breast fed for nine months, cereal at eight months, orange slices and vegetables at one year and when first seen was eating everything the family ate. He had received very little cod-liver oil or sunshine. His fontanels were closed, the head was of normal size and shape. No beading or flaring of ribs, pot-belly or other symptoms. Roentgenograms of left wrist and knees showed no evidence of rickets.

He was seen in the Orthopedic Dispensary two weeks later, October 25, 1937, where he had been referred because of his bowlegs. On standing and walking there was a pronounced bowing of both legs and there was a decided waddle to his gait. The bowing of the legs was mostly in the region of the knees but there was some just above the ankles with some inward twisting. The feet were pronated. Abnormal mobility on medial strain with normal stability on lateral strain was present in both knees. Bulbous projections could be palpated on the medial side of both upper tibial metaphyses. The roentgenograms (Fig. 2) show these beak-like medial projections at the upper tibial metaphyses, but in addition the epiphyses of the distal ends of femora and the distal ends of tibiae are involved by identical but more generalized lesions. The bowing is limited to the ends of the involved bones, the shafts being straight. Blount[2] has seen one similar case but did not consider it a typical tibia vara.

CASE II. R. T., a male, white, aged one year and seven months, was first seen in September, 1937, because of bowlegs. He had been breast fed for nine months. His diet after weaning had contained adequate antirachitic factor and

* Lakeside Hospital Dispensary.

there were no other evidences of rickets. He began to walk between the thirteenth and fourteenth months when a slight bowing of his legs was first noticed. An older brother showed bowing of the legs when he first began to walk. Because they later straightened themselves the parents thought that R's would do likewise but on the contrary they had become noticeably and continuously more bowed.

Fig. 2. Case I. Roentgenogram on admission.

When first seen R. T. walked with a pronounced waddle, and both legs were markedly bowed. The bowing was much more pronounced on standing and walking than on lying or sitting. The bowing was almost entirely adjacent to the knees and was accompanied by some recurvation and internal rotation of the lower legs. The feet were pronated. There was abnormal mobility of both knees on medial strain but none on lateral strain. A bulbous projection could be felt at the upper medial tibial metaphyses.

The roentgenograms (Fig. 3) show beak-like medial projections of the metaphysis, at the tips of which are small cyst-like areas of rarefaction. This is too young an age to show convincing anomalies of epiphyses visible as a result of ossification.

Fig. 3. Case II. R. T., aged one year and seven months.

Fig. 4. Case III. L. O., aged ten. Roentgenogram taken four and one-half months after operation.

Fig. 5. Case iv. H. C., aged seventeen. Roentgenogram before operation.

Fig. 6. Case iv. H. C., after operation showing correction obtained by operation.

THE ADOLESCENT TYPE

Case iii.* L. O., a colored girl, aged ten, was first seen in the dispensary on January 8, 1931, because of a crooked right leg. Her record states that she had been pushed down some stairs about a year before and injured her right knee. The injury was not severe enough to cause her to discontinue school or noticeably limit her activities but, according to her mother, her right leg, which had previously been straight, had gradually become crooked.

She entered the hospital on July 18, 1933, at which date a diagnosis of bowleg (right, upper third) was made. There was lateral bowing of the right leg just below the knee. The lower leg was internally rotated. The right lower extremity was three-quarters of an inch shorter than the left. Her physical as well as her bone age were in advance of her chronological age.

The following day an osteotomy was done. Solid bony union was somewhat delayed but there has been no recurrence of the deformity. Figure 4 shows the roentgenogram taken four and one-half months after the operation. The anomalous appearance of the medial tibial condyle and the marked angulation of the medial surface just below the condyle, together with the straightness of the remaining shaft, are characteristic of the adolescent type with a history of an injury.

Case iv.† H. C., a white boy, aged seventeen, entered the hospital on September 22, 1930, because of recurring bowlegs. There was no history of acute rickets. He began to walk when he was between nine and ten months old. His legs were straight until he was two years old, at which age he developed severe lateral curvature of both femora and tibiae. At the age of six years bilateral osteotomy was done in a Florida Hospital with correction of his deformity lasting for about one year, at which date bowing again appeared and continued to increase gradually for about four years when it reached stability.

Wedge osteotomy of both femora with good correction was performed at the age of fourteen and one-half years but bowing again recurred after about one year.

On entrance to the hospital he walked with a decided limp. There was moderate bowing of the right upper tibia. On the left the bowing was marked in the upper tibia and in addition the lower tibia was also bowed and the leg in-

* St. Vincent's Charity Hospital Dispensary.

† Lakeside Hospital Dispensary.

ternally rotated about 20 degrees. His left leg measured 70 cm. in length and his right 71 cm.

On September 23, 1930, osteotomy of the left tibia and fibula was done and three days later a similar operation was performed on the right tibia and fibula.

The roentgenogram (Figs. 5 and 6) show on each leg the correction obtained by operation. The upper medial tibial condyle shows the typical depression with lateral angulation of the shaft immediately below. The changes seen are characteristic of the adolescent type.

Blount has called attention to the possibility of recurrence of the deformity following operative correction if done before the amount of angulation has become stationary. Such recurrence must be attributed in part to the progressive nature of the deformity.

DISCUSSION

There still remains a definite tendency to define a variety of quite dissimilar affections of maturing bone and cartilage by the terms dyschondroplasia and chondrodysplasia. Described under these terms are to be found examples of Ollier's disease[4] with its asymmetrical conditions as originally defined, as well as those otherwise typical, with bilateral involvement,[5] achondroplastic dwarfs, hereditary multiple cartilaginous exostoses[3] and cases in which the changes as observed in the roentgenogram are those commonly known as osteochondritis,[6] have also been included. It is true that intermediate types do occur in any or all of these conditions involving the growing ends of long bones but there are good reasons for separating some or perhaps most of them.

Blount in his work has given us tests and rules by which this may be done in certain instances. In brief, he divides his cases into two groups, the infantile and the adolescent. In the infantile group (Fig. 1) a history of normal development to the age of one or two years with some overweight is usually obtained. In the adolescent group the onset is between six and twelve years of age in previously normal children.

The symptoms are independent of the age at onset. Gradually increasing bowing occurs, without apparent cause and without the other symptoms of rickets. The deformity is likely to appear bilaterally in the infantile cases, frequently with subsequent spontaneous disappearance of the bowleg on one side. In the adolescent group the angulation usually occurs on one side only. There is a limp in the unilateral cases and a waddle in the bilateral. There is an abrupt angulation with the apex laterally just below the knee joint, but in fat children this appears to be a gradual curve.

Fig. 7. Tracing from the roentgenogram with cartilage restored of a child aged three and one-half years. *A*, shaft angulated; *B*, widened epiphyseal line; *C*, wedge-shaped epiphysis; *D*, beak-like metaphysis; *E*, cartilage islands. (Redrawn from Blount[1].)

When the deformity appears in infancy a bulbous enlargement of the medial condyle is palpable on physical examination and visible in the roentgenogram (Fig. 2). Recurvation and relative flat foot are present irrespective of the age. Abnormal mobility of the knee on medial strain with normal stability on lateral strain and internal rotation of the tibia on the femur are constant findings. General medical examination is negative. There are no findings suggestive of rickets, tuberculosis or syphilis. The roentgenographic (Fig. 2) and pathological changes are like those of coxa plana and similar to those of chondrodysplasia, but quite different from those of

rickets. Faulty growth of the upper tibial epiphyseal cartilage and delayed ossification of its medial half result in a wedge-shaped deformity of this portion of it (Fig. 7). The adolescent type looks different in the roentgenogram (Fig. 8). It is an

Fig. 8. Tracing of roentgenogram showing changes characteristic of the adolescent type. (Redrawn from Blount[1].)

arrest of growth rather than a dysplasia. The roentgenographic findings of the infantile group gradually change to those of the adolescent so that the two can be distinguished later only by the history.

CONCLUSIONS

Dyschondroplasia and chondrodysplasia are terms which have been used to define a variety of conditions affecting the ends of growing long bones. While intermediate types do occur in any or all of these conditions the constancy with which characteristic clinical symptoms, physical findings, histologic and roentgenographic changes are seen in most of them justify their being classed as separate entities. Certainly the osteochondroses, with their characteristic findings, involving the upper medial tibial condyle should be so considered.

Four cases of developing non-rachitic bowlegs are here presented, two occurring in infancy and two occurring during adolescence. In Case I, although the clinical history and physical findings were characteristic of the infantile type, the changes seen in the roentgenograms are somewhat atypical since the distal ends of femora and of tibiae are involved by identical but more generalized lesions than those seen in proximal tibiae.

In Case IV there had been a recurrence of the deformity over a wide age period and while the roentgenograms (Figs. 5 and 6) show changes characteristic of the adolescent type those of the infantile type do gradually change to those of the adolescent type so that the two can be distinguished later only by the history.

Until the progress of the osteochondrosis has been arrested measures to overcome or prevent deformity should be instituted. If deformity is disabling or disfiguring after this stage has been reached operative correction is indicated.

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PULMONARY LYMPHOSARCOMA

REPORT OF A CASE

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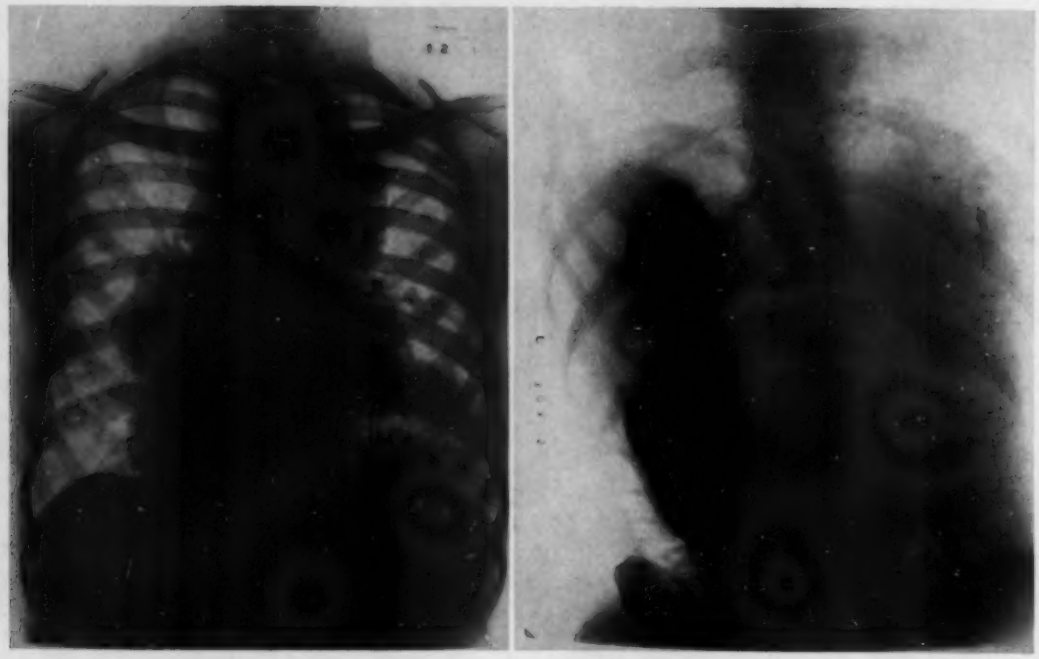
LYMPHOSARCOMA is a term often used loosely to cover all neoplastic states of lymph nodes that are not clearly Hodgkin's disease or leukemia.

Lymph node tumors usually occur in one of two forms—first as a generalized enlargement of lymphatic structures with infiltrating tumors in various organs or second as localized growths of single groups of lymph nodes.

PATHOLOGY

According to MacCallum, lymphosarcoma is an invasive or infiltrating lymphoid growth which has a peculiar regional way of spreading and is rather limited either to the thorax or the abdomen or both. It usually arises from a group of lymph glands rather than from a single one and it invades the adjacent tissues. The thoracic type forms great masses, apparently derived from the mediastinal lymph glands and usually are limited in their extension to the thorax where it surrounds the heart and compresses the lungs. The abdominal type originates from the mesenteric glands and spreads until it completely buries the adrenal organs and pancreas in an infiltrating mass of tissue. Specimens have to be differentiated from chronic lymphoid leukemia, leukosarcoma; small round cell sarcoma, and Hodgkin's disease or lymphogranuloma. In chronic leukemia the glands are enlarged but remain discrete and the blood is leukemic. In leukosarcoma there are blood changes along with the lymphoid nodules and infiltrations—the round cell sarcoma starts anywhere, usually in connective tissue and metastasizes by way of the blood stream. Lymphogranuloma or Hodgkin's disease is typified by the Reed cell. Pulmonary lymphosarcoma is always secondary to tumors arising in lymph glands elsewhere. Clinically, lymphosarcoma may be divided, according to Cutler, into lymphosarcoma with generalized adenopathy and no special localization; lymphosarcoma with localization and without generalized adenopathy, and a mixed form. There is no pathognomonic clinical picture of lymphosarcoma but it is characterized by marked invasion, proliferation, replacement and compression of organs and tissues and by necrotization, ulceration, toxemia, cachexia and febrile reaction. The symptoms depend upon the extent of the infiltration and proliferation and are peculiar to the particular part or parts infiltrated. Lymphosarcoma of the lungs has the same symptomatology as any malignant growth and may appear under a variety of aspects—as a chronic pulmonary inflammatory disease, or as a localized tumor; but the commonest groups of symptoms produced by these growths resemble those of a chronic pulmonary inflammatory disease and they have to be differentiated from tuberculosis, chronic pneumonia and chronic non-tuberculous pulmonary disease. In nearly all cases there is fever which may be slight, periodic, high, or continuous; also cough, sputum, and diaphoresis is a more or less constant finding. Pain becomes a symptom if pressure, compression or displacement of an organ is present. Loss of weight and strength and dyspnea are constant signs.

Except for the roentgen examination, lymphosarcoma is rarely diagnosed before operation and biopsy, or autopsy. The roentgenologic examination is of the utmost value and lends valuable aid to the diagnosis as it gives a fairly characteristic finding in the lungs. The characteristic picture is a general widening of the mediastinal shadow particularly of the right para-



A *B*

Fig. 1. *A*. First film taken, showing marked nodular infiltration jutting out from the mediastinum into the pulmonary field, and scattered nodules in the lung parenchyma. The lesion is bilateral, but more on the right side. The widened mediastinum at first glance might suggest an aneurysm. The infiltration in the right base simulates a tuberculous infiltration. *B*. Taken same time as chest roentgenogram, *A*, showing extrinsic pressure on stomach from large sarcomatous nodule which incorporated the pancreas.

tracheal nodes with large lobulated masses jutting out from the mediastinum into the pulmonary field and scattered metastatic nodules in the lung parenchyma. However tuberculosis of the mediastinal glands, lymphoblastoma, mediastinitis and hematoma of the mediastinum, though they may give somewhat similar shadows, must and can be differentiated roentgenologically.

The extragastric type of abdominal lymphosarcoma produces gastric symptoms such as abnormal peristalsis, pylorospasm, and spasm of the gastric musculature along with symptoms of direct pressure and compression. The diagnosis is only suggested by deduction as far as the routine run of barium meal examinations is concerned,

Fig. 2. One month later, showing definite increase in size of nodules, with a coalescence of the right basal infiltration, and extension of the nodules in the left lung. The mediastinum is wider.

but is strengthened by the positive findings of metastatic lesions elsewhere.

REPORT OF CASE

The patient was a young male Negro, aged twenty-nine, who entered the hospital April 28, 1937, with a history of thoracic pain, cough, sweats, loss of weight, dyspnea and a temperature of 104° F. and a heart rate of 100. He had been seen and treated by me on two previous occasions, first in 1933 and again in 1935 for conditions not related to the present illness.

Fig. 3. Five months later, showing still further widening of the mediastinum and additional infiltration scattered throughout the lung parenchyma, particularly in the right middle lobe. The heart is definitely enlarged.

The onset of the present disease dates back to May, 1936, when he complained of stomach trouble and backache with profuse sweating day and night, cough, asthenia and loss of weight. Before he entered the hospital I made several roentgen examinations of his chest and gastrointestinal tract and diagnosed his condition as lymphosarcoma of the stomach with metastasis to the lungs.

Physical examination showed his liver and spleen markedly enlarged, râles in the bases of

Fig. 4. Retrograde pyelogram showing normal kidneys. This was done on the suggestion of the urologist to rule out a possible kidney tumor.

the lungs and dullness over the mediastinum. He had eighteen urine examinations which were all negative except for occasional pus cells and a slight trace of albumin on three occasions. His blood picture showed a 60 per cent hemoglobin and a leukocyte count of 18,000. His

Fig. 5. Gross specimen of lungs, anterior view, showing encroachment of the mediastinal tumor around the heart and lungs.

Fig. 6. Posterior view of lungs and heart, showing tumor mass in mediastinum.

serology was negative. He remained in the hospital for two months without improvement and was discharged with the diagnosis mentioned above.

After remaining at home for three weeks his condition became more and more alarming and he was readmitted on July 19, 1937, complaining of extreme weakness, dull ache in lower part of back and in his knees and marked emaciation, hyperpyrexia and hyperesthesia. Two consultations were obtained which confirmed the previous diagnosis. The urologist suggested a possibility of hypernephroma but a roentgen examination of the urogenital tract showed nothing unusual. The white cell count had increased to 34,000 and there was a mild anemia, the red blood count being 3,950,000.

Fig. 7. Gross specimen of pancreas, showing almost complete envelopment by the sarcomatous mass.

The symptoms became progressively worse and toward the end he became markedly jaundiced and died on October 6, 1937.

Post-Mortem Examination. An autopsy was performed by Dr. Lancess McKnight, pathologist, and the essential pathologic post-mortem findings were as follows: marked pleural effusion; generalized adenopathy of the mediastinal glands with invasion of the lungs and the cervical region; marked enlargement of the liver and spleen; and complete engulfment of

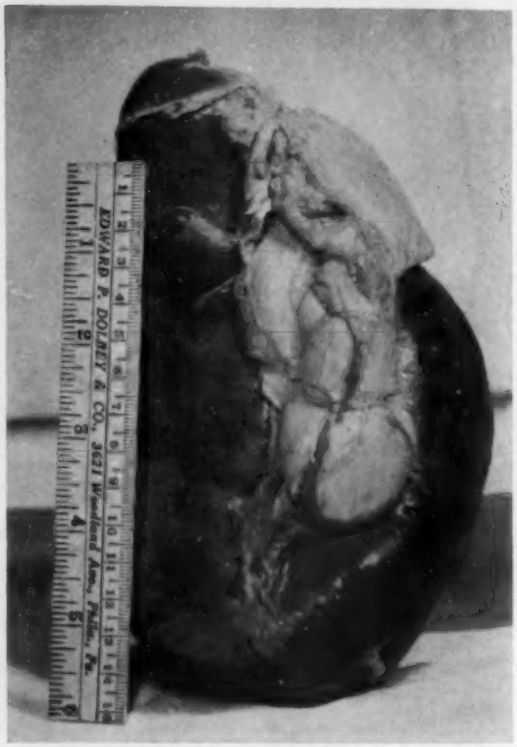


Fig. 8. Gross specimen of spleen, showing enlargement and encroachment of the tumor mass.

the pancreas by a large mass which caused distortion of the stomach.

Microscopic examination confirmed the diagnosis of lymphosarcoma.

The prognosis in this condition without irradiation is at most from one to two years, and with deep roentgen therapy we can only hope for a prolongation of life from two to two and one-half years.

The cause, as in other neoplastic conditions, is not known and the treatment aside from symptomatic sedation is deep

roentgen therapy, which has given marked improvement in some cases, but does not eradicate the certain recurrences.

The clinical course, the mode of death, the results of chemotherapy, vaccines, toxins, radium, roentgen rays, and surgery as observed in lymphosarcoma, Hodgkin's disease and the other malignant lymphomas run very closely parallel.

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INTRAORAL MINOR SALIVARY GLAND ADENOCARCINOMA*

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IN A PAPER entitled "Adenocarcinoma of the Oral Cavity" read before this Society in June, 1934, and subsequently published in 1935, Watson[4] prefaced his remarks with the statements, "These interesting and uncommon tumors have in the past received but little attention in the literature and, so far as I have been able to determine, no sizable group of histologically proved cases followed for an adequate period of time has as yet been reported. Nevertheless, these tumors form a definite group with typical pathological and clinical characteristics which entitle them to a separate classification among the intraoral neoplasms." We have been able to find little in the literature on the subject since Watson's paper, and believe, from our local experience, that this is because the majority of clinicians and a fair number of pathologists fail to recognize the nature of these tumors.

We find occasional reference to the subject in general discussions of tumors of the mucosa of the cheek. Lund[3] reporting on 1,126 carcinomas of the buccal mucosa shows a table with 1 adenocarcinoma, 1 adenoid cystic epithelioma and 2 mixed tumors along with 27 unclassified pathologically. We believe these 4 correspond to the cases reported here and wonder how many of the 27 may also belong in this group. Li and Yang[2] report 25 cases of mixed tumors occurring in various locations in the head other than the major salivary glands. Eighteen were located on the face and scalp and 7 within the oral cavity. They all occurred in Chinese patients. They give an excellent discussion of the subject from a histogenetic viewpoint and have a good bibliography. Under the term, "aberrant salivary adenomas," Geschickter[1] reports 7 cases, 5 of which occurred on the hard palate.

During the last two years 6 intraoral minor salivary gland adenocarcinomas have been treated at the Tumor Institute of the Swedish Hospital in Seattle, Washington, and 2 other cases have been seen in consultation. The 6 cases treated represent an incidence of 0.2 per cent of all admissions and 0.4 per cent of all malignant tumors treated. An average of four different physicians saw each case, or we may say twenty-four physicians saw at least 1 case (and in three instances 2 cases each) without making the correct diagnosis clinically.

These 6 cases are reported in detail with the idea of stressing the importance of recognizing these tumors as a separate clinical entity. If one is merely aware of the existence of this type of tumor he is not likely to miss the clinical diagnosis in the early stages of the disease.

The age, sex, duration of symptoms, and site of tumor in the 6 cases are shown in the following table.

No.	Sex	Age	Duration	Site
I	M	5	6 weeks	Left tonsillar pillar and palate
II	F	49	4 weeks	Submucosa right cheek
III	M	49	1½ years	Hard palate
IV	M	63	3 weeks	Submucosa right cheek
V	M	32	8 months	Right upper gingivobuccal gutter
VI	F	40	6 months	Medial aspect of the posterior portion of the left lower alveolar margin

* Read at the Twenty-Third Annual Meeting, American Radium Society, San Francisco, Calif., June 13–14, 1938.

There is no apparent predominance in either sex according to previous reports. Case VI was a Japanese female, the others were of the white race. The ages varied from five to sixty-three years, while in Watson's group of 41 cases it varied from eighteen to eighty-five years.

The longest duration of symptoms in this group is 1.5 years. Three were six weeks or less. This is unusual in that most cases reported show a slowly growing, painless lump usually present for a number of years. In Watson's cases it was 4.07 years, although he stresses the fact that the tumor may take on an active, rapid growth at any period of its development. Only 1 of the 6 cases gave a history of pain, the other 5 noted discomfort only with mastication.

The gross characteristics resembled those in previously reported cases except that 4 of the 6 were relatively early cases. Only one (Case III) showed a large mass. This one, located on the palate, measured 5×3×2 cm. It was completely covered by the mucous membrane of the palate. The major portion under the surface had broken down and was cystic but the deeper portion was solid and had infiltrated the hard and soft palate. Cases II, IV and VI were oval, semisolid or elastic masses, partly encapsulated in the areas of the cheeks offering no resistance to growth, but infiltrating flat masses when adjacent to resisting structures such as bone. None of the 6 showed ulceration on the surface, though this is to be expected in the more advanced cases. When first seen only one case seemed to be completely encapsulated (Case IV). Case I had an extensively infiltrating growth which already had metastases to regional lymph nodes. The rest demonstrated partial encapsulation and partial infiltration into adjacent structures.

In any question of differential diagnosis of intraoral tumors this group must be considered. When involving any part of the alveolar margins it may be mistaken for an epulis or a plasma cell granuloma which are usually softer in consistence and redder in color. A dentigerous cyst, an adamantinoma or an epidermoid carcinoma may closely resemble it, but they seldom show the lobulated elastic mass so characteristic of the adenocarcinoma. If it is in the region of the mucosa of the cheek or the palate it must be distinguished from a mucous cyst, granulomas, angiomas, fibromas and lipomas. It may easily be mistaken for abnormalities of Stensen's duct, or a carcinoma of the antrum perforating the palate or gingivobuccal gutter. This list is not meant to be all inclusive, it represents merely some of the diagnoses suggested by the referring physicians and myself on the 6 cases reported here.

The early or late case of intraoral adenocarcinoma may present a difficult problem of differential diagnosis as under these circumstances it may not show the characteristics which are thought to be so typical of it. Even though the author was on the lookout for these tumors his clinical diagnosis at first was: Case I, a transitional cell carcinoma of the palate, tonsillar pillar and tonsil; Case V, an infected mucous cyst until the inflammation from the previous open biopsy wound had subsided sufficiently to allow palpation of the tumor in the gingivobuccal gutter and subantral region of the substance of the cheek; Case VI, epulis or plasma cell granuloma because of the history of a relatively recent tooth extraction. During this same period of time he made the clinical diagnosis of intraoral salivary gland adenocarcinoma when subsequent work-up proved the case to be an adamantinoma of the left superior maxilla in one instance and in another a carcinoma of the antrum which had perforated the palate and formed an oval lobulated mass 3×2×1 cm., completely covered by mucous membrane.

Even from this small series, all within two years, it may be seen that the prognosis is poor. Case I died two months after treatment from extensive metastases. Fourteen months after treatment, Case VI developed a recurrence in the mandible 3 cm. distant from the apparent periphery of the

primary growth. Local recurrence of the small localized growths and distant metastases from the larger or infiltrating ones is the rule.

We have tried to follow Watson's suggestions regarding treatment. The localized, encapsulated masses were excised surgically with wide margins. The infiltrating tumors were implanted with gold radon seeds and, where possible, a later complete cautery excision was performed.

These tumors seem to be extremely radioresistant and it is questionable whether many can be entirely controlled by irradiation alone. It may be noted that the only one (Case VI) showing a recurrence at this early stage was one treated with interstitial gold radon implants alone. We have adopted the plan of overdosage with radon implants with subsequent cautery excision in the hope that if any of the disease has been left behind by the cautery there will be sufficient radiation to destroy this narrow margin. The subsequent excision likewise decreases the morbidity from the extensive irradiation.

The microscopic picture in all of these has been that of an adenocarcinoma of salivary gland origin. It has varied from an embryonal anaplastic adenocarcinoma in Case I to an adenocarcinoma with a moderate tendency to differentiate toward the type of mixed tumor structure so frequently seen in parotid tumors. In order from Case I to Case VI there was an increasing amount of hyaline and myxomatous connective tissue, but even in Case VI the adenocarcinoma predominated so that there would be no inclination to place it in the group of mixed tumors like those of the major salivary glands. We have not encountered any intraoral adenocarcinomas of mucous gland or of aberrant thyroid origin. The microscopic picture in our cases clearly resembles an adenoid cystic basal cell epithelioma, under which term most of the older cases are described. We agree with Stewart in Watson's paper that this term is unsuitable because it gives a false impression of the true nature as well as the clinical course of these tumors.

SUMMARY

In an attempt to stress the need of recognition of intraoral minor salivary gland adenocarcinomas as a clinical entity 6 cases are presented and analyzed in comparison with other reported cases.

REPORT OF CASES

Case I (No. 61136). W. S., male, aged five, was first seen at the Tumor Institute on March 5, 1936. One month before admission to the hospital the child developed a pain in the left mastoid region and a draining ear. Within two to three days of these symptoms he was operated upon by his local physician and a left radical mastoidectomy was performed. It was stated that the mastoid area was definitely involved with a purulent material, but that there was a great deal of granulation tissue filling the entire mastoid cell region. Within five or six days after the mastoidectomy, large nodes were palpated in the left posterior cervical chain. One of these was excised for biopsy and was reported by the local pathologist as a lymphosarcoma. Within a week after the excision of this biopsy mass in the left posterior cervical chain, another mass appeared in the left parotid region. This growth rapidly increased in size, and the patient developed a left second and third division fifth and seventh nerve paralysis. A second biopsy was taken from this mass over the left parotid region and was reported by another pathologist as a myxosarcoma. The patient was then referred to the Tumor Institute for subsequent treatment. He was a fairly well developed, markedly undernourished white boy of four and one-half years of age, appearing chronically ill. The general physical examination was essentially normal except for the local findings of a left second and third division fifth nerve paralysis and partial paralysis of the left seventh nerve. There were the scars of the recent mastoid operation, biopsy wound in the left posterior neck and the recent operative wound in the left parotid region. Nodes were still palpable throughout the entire left posterior cervical chain. In the region of the left parotid gland was an extensive infiltrating fixed mass measuring about 5 or 6 cm. in diameter in the recent operative wound. Examination of the mouth at this time revealed an extensive polypoid mass in the region of the left tonsil which had extended beyond the midline and pushed the uvula and soft palate to the right. This mass extended

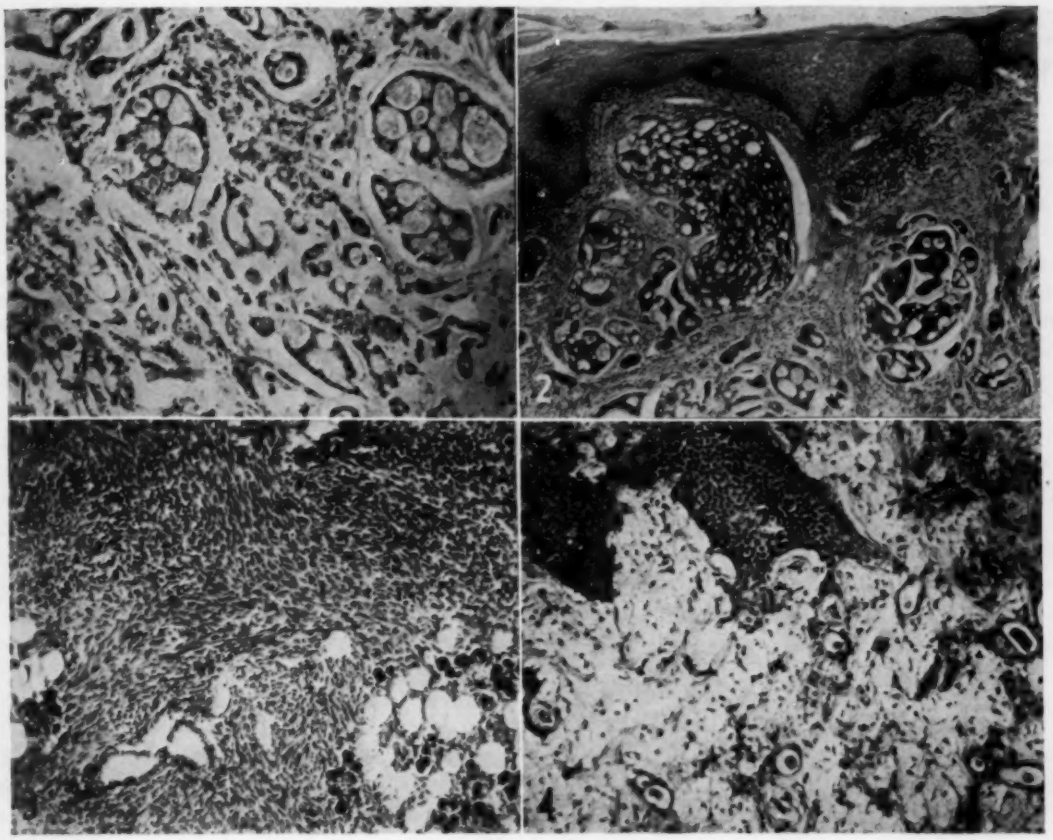

Fig. 1. Section of the typical form and distribution which resembles adenoid cystic basal cell epithelioma.

Fig. 2. Section showing the submucosal character of the nodules.

Fig. 3. The highly anaplastic or embryonal form simulating a transitional cell carcinoma which in this case shows infiltration from the tonsil into and around the normal appearing parotid gland tissue.

Fig. 4. Section of a small area from Case 11 showing some of the characteristics of a mixed tumor of salivary gland although the larger portion of the tumor resembled that shown in Figure 3.

downward to the lower pole of the tonsil where it appeared ulcerated over an area at least 2 cm. in diameter, and 4 or 5 cm. long. The upper limit of the mass could not be seen behind the soft palate. Review of the case and the slides at this time convinced us that this was not a lymphosarcoma of the nasopharynx and tonsil nor a so-called myxosarcoma; but rather that it was an embryonal salivary gland tumor arising within the oral cavity probably around the palate and left anterior tonsillar pillar. It seemed logical at this time to assume that it was this extensive disease in the left posterior pharynx and nasopharynx which caused the original plugging of the left eustachian tube with secondary formation of the mastoiditis, and a middle ear infection.

The situation seemed entirely hopeless and it was believed that only a palliative form of treatment was warranted. The child was treated on alternate days with 200 kv. (peak) roentgen rays, giving 300 r for the first four treatments, and then 350 r for the remainder of the treatment through a 9 cm. circular skin portal directed toward the angle of the left jaw for a total of 3,300 r in eighteen days. Within two weeks after the completion of the treatments the masses had regressed to about 50 per cent of their original size. Five weeks after treatment all of the previous operative wounds had entirely healed, there was no palpable disease left in the anterior neck, and no definite residual disease in the pharynx. The shotty nodes in the left posterior cervical chain

remained almost unchanged. The paralysis of the left side of the face remained unchanged. The patient's general condition improved markedly during the next week or two and then rapidly declined and he died two months after completion of treatment from intracranial disease of both direct extension and metastases.

Case II (No. 2563). E. W., white married female, aged forty-nine, admitted December 21, 1937. Nine months before admission the patient had had all of her remaining teeth roentgenographed, and she was assured that there were no signs of infection in any of these remaining teeth. At that time, she was likewise examined by a nose and throat specialist who found no evidence of any trouble in her mouth. About three weeks before admission the patient first noticed a small swelling on the inside of the right cheek. She states that this gradually enlarged, in spite of the fact that she seemed to be in excellent general health, was gaining weight and was feeling better than she had felt for some fifteen years. Her local physician took a biopsy of this and it was found to be a salivary gland adenocarcinoma. At the time of her admission to the Tumor Institute a tumor mass measuring about 2×1.5 cm. was found involving the mucosal surface of the right cheek in the region opposite the first to third right upper molar teeth. The mass extended upward submucosally and under the skin to fill the hollow between the malar region and the nose. Stensen's duct could not be definitely isolated from the recent operative wound. There was no evidence of any tumor mass in the parotid substance and no evidence of cervical adenopathy. It was decided to treat this patient by means of an overdose of gold seeds to be followed later by cautery removal. On this basis, thirteen gold seeds totaling 19.5 millicuries were distributed throughout the inner two-thirds of the mass in the right cheek. Five days later the patient was admitted to the hospital and the entire area removed with the actual cautery through an intraoral route. The major portion of the mass was well encapsulated. All of the seeds implanted were recovered postoperatively so that the patient received an equivalent of 12 millicuries-destroyed in the mass. This was calculated to give at least eight erythemas to an area 1 cm. beyond the mass. The large defect remaining was packed open with gauze and allowed to granulate in slowly from the depth of the wound. Four months after operation this small draining sinus had almost entirely closed, the whole cavity had been refilled, and the patient was free of disease.

Case III (No. 2234). C. B., white male, aged forty-nine, admitted May 21, 1937. He had had all of his upper teeth extracted two and a half years previous to admission. Two years before admission he had an upper false plate made. He noticed slight pain from this plate for the first three or four days and then it did not bother him any more. A year ago the plate again began to be painful and as he looked in his mouth he saw a round swelling on the roof of his mouth, mostly on the left side. He states that during this last year he has not used his upper plate at all and that he believes that this mass in the upper part of the left side of his palate has been gradually enlarging in size. It has been absolutely painless. On examination there was a large, oval, cystic swelling involving the major portion of the palate. Anteroposteriorly it extended from within 1 cm. of the front teeth to the left tonsil and the uvula; and transversely from the left alveolus to the right about 1 cm. beyond the midline. It bulged outward for a distance of 2 cm. from the surface of the palate. The major portion was cystic, but there was a solid portion at the base which was tightly adherent and not movable over the palate. This was recognized immediately as probably of salivary or mucous gland adenocarcinoma origin so that the major portion of the mass was dissected out by sharp dissection and only a small residual area about 1.5 cm. in diameter, which was adherent to the palate, remained. Seven gold radon seeds totaling 10.6 millicuries were then distributed throughout this remaining portion of the hard palate. The patient had an uneventful postoperative convalescence and he had a sharp reaction over the entire palate which persisted the usual length of time. It gradually subsided and he has had an uneventful course since that time with no evidence of disease one year later.

Case IV. W. F. C., white male, physician, aged sixty-three. First seen in consultation May 19, 1936. Patient gave the history that for many years he had been aware of numerous small soft subcutaneous masses spread over his entire body. These all varied in size from 0.5 to 1.5 cm. in diameter and involved the trunk as well as the extremities. He stated that at least four of these had been removed at

various intervals during the last five to ten years, and that each one had been found to be a lipoma. They seemed to be more firm than an ordinary lipoma and were believed to be neurolipomas. Within the last three weeks he had noticed another small rounded mass in the submucosal region of the right cheek. He did not believe that this had increased in size since he had first noticed it, but it bothered him because he frequently bit it while he was chewing his food. The general physical examination was entirely normal except for the previously noted multiple subcutaneous neurolipomas. Examination of the mouth revealed a submucosal mass approximately 1 cm. from the commissure on the right side of the mouth. It was freely movable and measured at least 1.5 cm. in diameter. It did not appear to have infiltrated the surrounding tissues or the underlying mucosa. It was quite firm to palpation.

It was decided that this mass should be excised locally to rule out the possibility of an intraoral salivary gland adenocarcinoma. The mass was therefore excised surgically under local novocain infiltration anesthesia. It seemed to be completely encapsulated, and the entire mass with a moderate amount of surrounding tissue was excised. The wound was closed primarily. He had an uneventful postoperative convalescence; the wound healed by primary intention. Microscopic examination of this mass showed a papillary adenocarcinoma of salivary gland origin. The patient has been followed periodically since that time, and he has remained perfectly well without any evidence of local recurrence for two years.

Case v (No. 2001). C. L., white male, aged thirty-two, admitted January 19, 1937. Between six and eight months prior to admission the patient first noticed a tender spot in the right upper gingivobuccal gutter of his mouth betweeen the mucous membrane of the cheek and the molar teeth. This periodically enlarged, occasionally became somewhat smaller. He frequently irritated it chewing and occasionally bit it. It bothered him most at night with shooting pains running up through his head. One week prior to his admission a biopsy was taken by his local physician, but no definite diagnosis could be made microscopically from this biopsy. At the time of his admission the examination showed an indurated, slightly inflamed area about 1 cm. in diameter involving the buccal mucosa of the region of the mouth just posterior to the third upper right molar tooth. It measured 1.5 cm. in diameter. On the medial aspect of this was a recent biopsy wound measuring about 2×3 mm. and about 2 mm. deep with considerable tenderness around the entire area. At this time there was no definitely isolated tumor mass, but the entire process gave the appearance of a subacute inflammatory reaction following the biopsy wound. Stensen's duct was not involved in this mass. Inasmuch as the previous biopsy was not positive and a clinical diagnosis could not be made from the examination so soon after the previous biopsy wound, the patient was allowed a period of a week before another biopsy was taken. At that time, one week after his original admission, there was a definite plaque of thickened indurated tissue which was apparently entirely submucosal in origin and extended from the right upper gingivobuccal gutter downward into the submucosal tissues of the cheek. It measured at least 1.5 cm. in diameter and approximately 5 mm. thick. At this time additional biopsy was taken by means of sharp dissection under local novocain infiltration anesthesia. Mucous membrane edges were reapproximated with interrupted sutures. This biopsy revealed the true nature of the disease and showed that it was an intraoral adenocarcinoma of salivary gland origin.

Because of the extensiveness of the disease and the infiltrating character, treatment was outlined by means of an overdose of gold radon seeds to be given interstitially and removed in five days. Accordingly thirteen gold radon seeds totaling 28.5 millicuries were distributed throughout the mass in the right upper posterior gingivobuccal gutter. Five days later the entire area including all of the previously inserted gold seeds were removed. It was calculated so that in the five days the patient received the equivalent of 16.3 millicuries-destroyed. A rather large wound, or cavity, was left which extended upward into the substance of the face and likewise exposed the mandible, as the mass was found on excision to extend backward posteriorly to the ascending ramus of the mandible. When the wound had once cleaned and the major portion of the sloughing area had disappeared the patient was discharged home, but had to be readmitted a week later because of a radiation reaction with additional slough from the cavity. Because of the exposure of the mandible and the

radiation reaction in this region the patient had a rather severe general reaction and had to remain in the hospital for a period of about six weeks. The pain was so severe that the patient became addicted to the use of narcotics and it took two weeks to break him of this habit. The wound gradually granulated in and he has been apparently free of disease since.

Case VI (No. 1990). H. T., Japanese female, aged forty, admitted January 12, 1937. The patient had had the lower teeth removed approximately five years before admission. During the six months prior to admission she had noticed a small swelling on the left lower gum margin extending from the medial margin of the alveolus downward toward the floor of the mouth. This had given her trouble because she frequently pressed the opposing teeth against this mass. Two weeks before admission these opposing teeth were removed, but the mass continued in spite of this. Examination of the mouth at the time of admission revealed a semi-firm oval mass 2×1×1.5 cm. involving the posterior aspect of the left lower alveolar margin and extending downward on the inside of the mandible toward the floor of the mouth. There was no ulceration but there was considerable tenderness to pressure. The mass seemed to be adherent to the mandible. There was no cervical adenopathy. A biopsy taken by sharp dissection from this region revealed an adenocarcinoma of salivary gland origin.

Because of the location of this mass it was not suitable for resection, and it was deemed advisable to depend upon interstitional irradiation alone. On this basis eight gold radon seeds totaling 11.1 millicuries were distributed throughout the mass on the medial aspect of the posterior portion of the left mandible. The patient had a relatively uneventful convalescence from this irradiation but a sharp reaction extending throughout the entire area of tumor and for a margin of at least 1 cm. beyond it. She remained free of disease and in excellent general health without any evidence of local recurrence until March 18, 1938, a period of fourteen months, when she complained of considerable tenderness throughout the midportion of the left lower mandible. On examination a small mucosal nodule measuring approximately 0.75 cm. in diameter was found on the midportion of the left lower alveolar margin. A roentgenogram of this region showed an area of decreased density in the bone immediately under the nodule. This was at least 3 cm. away from the previous area of disease and on that basis it was felt that this might possibly be due to a small sequestrum caused by the recent extraction of a tooth from this area. However, a biopsy from this region showed recurrent adenocarcinoma. Resection of the left mandible was advised but the patient refused this treatment because of the seriousness of the condition, and decided to return to Japan. As a palliative measure before returning, and due to the fact that she would have considerable delay before receiving treatment in Japan for this condition, she was treated with a 0.5 cm. rubber covered platinum capsule against the anterior alveolar margin for 350 millicurie-hours, and a corresponding doses given along the medial margin of the mandible.

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ASPIRATION BIOPSY OF TUMORS IN OBSCURE OR DIFFICULT LOCATIONS UNDER ROENTGENOSCOPIC GUIDANCE*

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SINCE 1930 a total of over ten thousand aspiration biopsies have been made at the Memorial Hospital by various members of the Clinical Staff. The details of the technique, the indications and the safety of this procedure have been previously published.[4,5,6] This communication is concerned with a description of a modified technique by which the roentgenoscope is used for guiding the aspirating needle into certain deep or otherwise obscurely situated tumors. By this method of more accurate localization of the tumor and visual control of the advancing needle, the percentage of positive biopsies has been definitely raised in these otherwise difficult situations. Without roentgenoscopic guidance failures to obtain tissue were most frequent in such relatively inaccessible situations as the hilar regions, lungs, anterior and posterior mediastinum, pelvis, pedicles, transverse processes and bodies of the vertebrae or the head or neck of the femur. The aspiration of tumors in these locations is all the more difficult if the lesion is small (5 cm. or less) and is situated at a depth of 10 or more centimeters from the surface. Another important consideration in aspirating deep tumors is the avoidance of possible trauma to such important structures as large vessels, heart or esophagus.

In a series of 26 aspiration biopsies performed under roentgenoscopic guidance in 1936 and 1937, we have been successful in obtaining diagnostic material in 24 cases, or 92 per cent (Tables I and II). At the present time roentgenoscopic guidance is being used successfully by various members of the Clinical Staff of Memorial Hospital. Recently Craver and Binkley[3] have shown that with improved technique in the localization of the lesion the percentage of positive aspiration biopsies in lung tumors has increased from 40 per cent in 1931 to 90 per cent in 1937.

There has been no instance of a serious complication from any aspiration biopsy made at Memorial Hospital. Occasionally a bronchus or a vessel or both may be punctured, and in such a case air and/or blood is drawn into the syringe. This usually results in a slight hemoptysis lasting not more than twenty-four to forty-eight hours. Partial pneumothorax is a rare complication. The aspiration biopsy of the lung when properly performed, is usually a painless procedure.†

TECHNIQUE

A detailed description of the technique of aspiration biopsy has been published by Martin and Ellis[4,5] and will not be repeated here.

The paraphernalia required are the same as for any aspiration biopsy. For deep-seated tumors the longer needles, 15 or 20 cm. in length, are essential.

Either a tilt table or a biplane roentgenoscope can be used. The ordinary upright roentgenoscope may be used for the upright position, while for the horizontal position the patient lies on a stretcher.

Every patient should have a thorough preliminary roentgenoscopic study to acquaint the operator with the region to be aspirated. This is especially important

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† Since November, 1938, two instances of cerebral air emboli have occurred during the aspiration of lung tumors. Both patients became unconscious and subsequently developed a transient partial hemiplegia for which a short hospitalization was required. This complication may be avoided if the aspiration is performed with the patient in a slight Trendelenburg position, which of course necessitates the use of a biplane roentgenoscope for the aspiration procedure.

TABLE I

RESULTS OF ASPIRATION BIOPSY ON TUMORS IN LUNGS AND IN HILAR AND MEDIASTINAL REGIONS UNDER ROENTGENOSCOPIC GUIDANCE

Case Number	Region Aspirated	Aspiration Diagnosis
I. S.C.	Right upper lung	Epidermoid carcinoma
II. N.B.	Left upper lobe	Carcinoma
III. R.F.	Mediastinal mass	No tumor cells
IV. R.S.	Nodule right hilar region, nonpulsating, probably a sacculated aneurysm	Fibrin and old blood; no tumor cells
V. A.S.	Right upper lobe	Carcinoma
VI. M.B.	Right upper lobe mass	Cyst fluid filled with cholesterin crystals, probably a dermoid cyst
VII. F.M.	Right hilar mass	Carcinoma
VIII. S.S.	Nodule left hilum	No tumor cells
IX. G.C.	Right middle lobe mass	Carcinoma
X. A.P.	Left hilar mass	Carcinoma
XI. M.F.	Right lung	Carcinoma
XII. C.T.	Right mediastinal mass	Carcinoma
XIII. J.T.	Right upper lobe mass	Carcinoma
XIV. J.M.	Left hilar mass	Carcinoma
XV. M.M.	Left hilar region	Carcinoma
XVI. W.G.	Right lower lobe mass	Metastatic carcinoma
XVII. J.D.	Mediastinal mass	Malignant tumor
XVIII. E.T.	Right posterior mediastinum	Normal thyroid
XIX. L.	Mediastinal mass	Mediastinal thyroid

when dealing with small lesions in the hilum, mediastinum or deeper bony structures. As the examination of these regions requires the visualization of fine detail, it is necessary for the operator to spend ten to fifteen minutes for eye adaptation. An ordinary flashlight fitted with a red filter maintains adequate eye adaptation and provides sufficient illumination enabling the operator to prepare the skin and to maintain aseptic technique during the aspiration.

For chest cavity aspirations the patient may be placed in either an upright or horizontal position, depending on the available roentgenoscopic equipment. With a biplane roentgenoscope all the aspiration biopsies are performed best with the patient in the horizontal position. In our clinic we use a tilt table roentgenoscope and for this reason, in the majority of cases, the upright position is preferable as it permits of rotation of the patient from an anteroposterior or posteroanterior to the lateral position with greater facility. With the patient upright, the arms are held above the head by

TABLE II

RESULTS OF ASPIRATION BIOPSY OF SKELETAL LESIONS UNDER ROENTGENOSCOPIC GUIDANCE

Case Number	Region Aspirated	Aspiration Diagnosis
I. G.C.	Body of 5th lumbar vertebra	Carcinoma
II. S.H.	Pedicle of 3rd lumbar vertebra	Metastatic carcinoma
III. Z.	Transverse process of 4th lumbar body	Metastatic carcinoma
IV. G.	Head of femur	Carcinoma
V. G.H.	Descending ramus of pubis	Malignant tumor
VI. A.H.	Sacrum	Malignant tumor
VII. M.M.	Descending ramus pubis	Fibrosing giant cell tumor
VIII. A.A.	Upper end of femur	Carcinoma

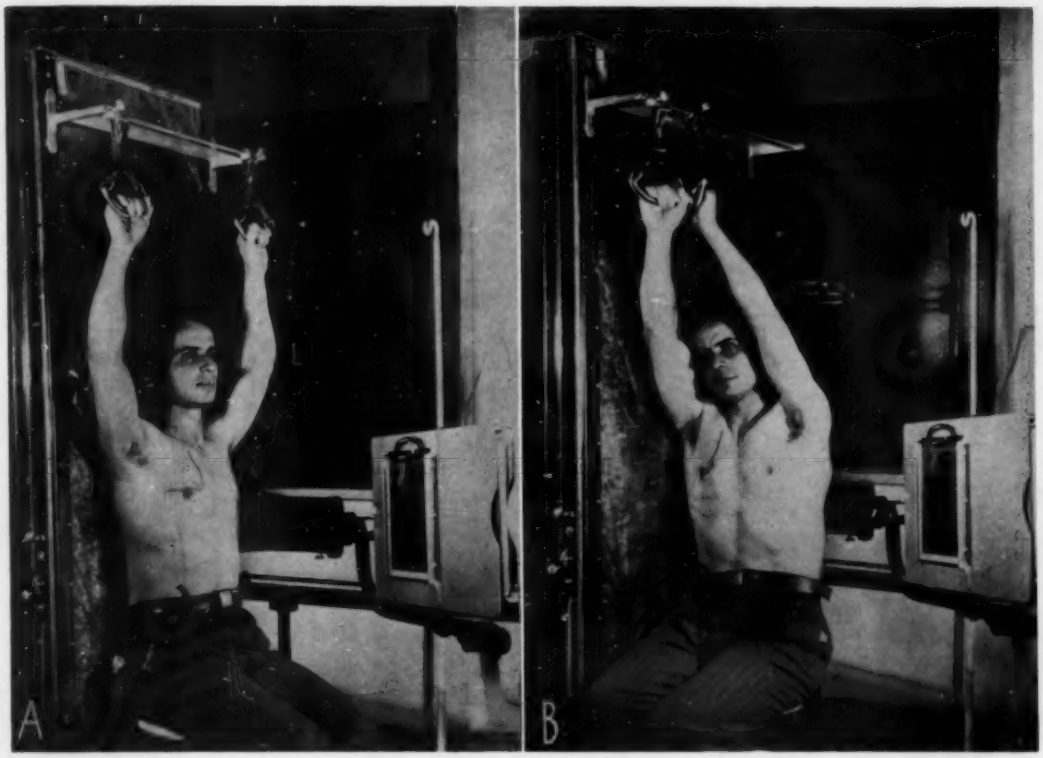


Fig. 1. *A*. For aspiration biopsy under roentgenoscopic guidance in the upright position, the patient sits on a pedestal stool with the arms held above the head by an arm rest consisting of two sliding leather stirrups suspended from an overhead bar. The latter is an attachment which fits as an accessory on the roentgenoscopic table. The two arrows drawn at right angles on the right anterior chest wall indicate point of intended puncture.

B. The pedestal on which the patient sits is arranged so that the foot rest and stool seat move together, enabling the operator to rotate the patient from the anteroposterior to the lateral position with facility. The stirrups slide along the bar permitting the arms to rest comfortably during the maneuver. The rotation of the patient requires no effort on the part of the patient and may be done safely with the needle in the chest cavity.

a specially devised arm rest, which consists of two sliding stirrups suspended from an overhead bar. This bar is an attachment which may be fitted as an accessory to the roentgenoscopic table (Fig. 1). The patient is seated on a pedestal stool, which has an attached foot rest so arranged that the stool seat and foot rest move together. This enables the operator to rotate the patient from one position to another without difficulty.

The horizontal position sometimes necessary in very ill or highly emotional subjects makes the procedure somewhat more difficult since the patient cannot be rotated as freely as in the upright position. Although in this position the direction of the needle can be observed in only one plane with the ordinary roentgenoscope, the preliminary roentgenoscopic study should have previously determined the comparative depth of the tumor beneath the surface and its general location. On the other hand, the operator may depend somewhat on the tactile sense of resistance or of some other alteration in consistency as the needle enters the tumor.

The site for the introduction of the aspirating needle should be carefully selected and is usually best determined by a combined roentgenographic and roentgenoscopic study. Sometimes a deep-seated le-

sion is equidistant from all the nearest skin surfaces, as for example in hilar tumors, in which case one approach may be safer from the standpoint of adjacent normal structures. In such a case the roentgenoscope is particularly useful in selecting the safest avenue of approach.

After the site of entrance has been selected and localized with lead indicators, indelible skin markings are placed at right angles to each other at the point of intended puncture (Fig. 1). With the aid of the red light the skin is prepared with iodine and alcohol and 1 per cent novocaine is injected into the skin and subcutaneous structures. To facilitate the insertion of the needle through the skin and to prevent contamination of the aspirated material by surface epithelium, a stab incision is made in the skin with a bistoury.

The aspiration needle with an obturator in place is introduced through the stab wound and advanced to the tumor. At this point the position of the needle and tumor are carefully checked reontgenoscopically in the lateral and anteroposterior or posteroanterior positions and if found to be in line with the lesion the needle is introduced into the tumor, the obturator withdrawn, the syringe attached and the aspiration is performed.* If not in the proper position,

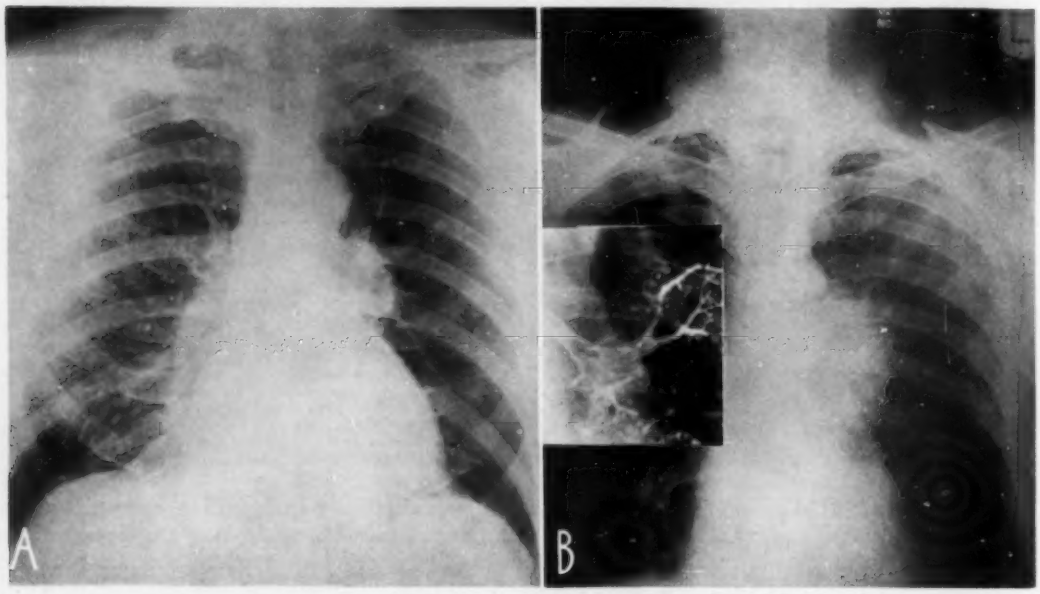


Fig. 2. *A* (Case viii, Table 1). The mass in the left hilar region was aspirated under roentgenoscopic guidance. The needle was inserted at the level of the third interspace anteriorly and to the left of the sternum. It was directed medially toward the mass. The latter was punctured along its lateral aspect, thus minimizing the danger of perforating a large hilar vessel. The aspirated material was reported by Dr. Fred W. Stewart as containing "no tumor cells." Incidentally this aspiration is considered as a failure (one of the two recorded in this series). Several months later the patent died of metastatic cancer to the cervical nodes and brain. The primary lesion was never discovered.

B (Case xiv, Table 1). The outline of the mass in left hilar region fuses with that of the cardiac and aortic silhouettes. This mass was successfully aspirated under roentgenoscopic guidance utilizing an approach similar to that used in Figure 2*A*. The aspirated material was reported as "carcinoma." The inset is the bronchogram of the left bronchus demonstrating the displacement of the upper lobe bronchus and irregularity in its outline. The displacement of the left bronchus was noted on bronchoscopy but no tumor tissue was obtained.

* The aspiration is performed in the following manner. While suction is maintained, the needle and attached syringe are inserted into the tumor and slightly withdrawn and reinserted at a different angle. At the same time the needle is rotated so as to loosen tissue and facilitate its aspiration into the needle. This maneuver is repeated two or three times and then the suction is carefully and slowly released, the syringe disconnected and the needle removed.

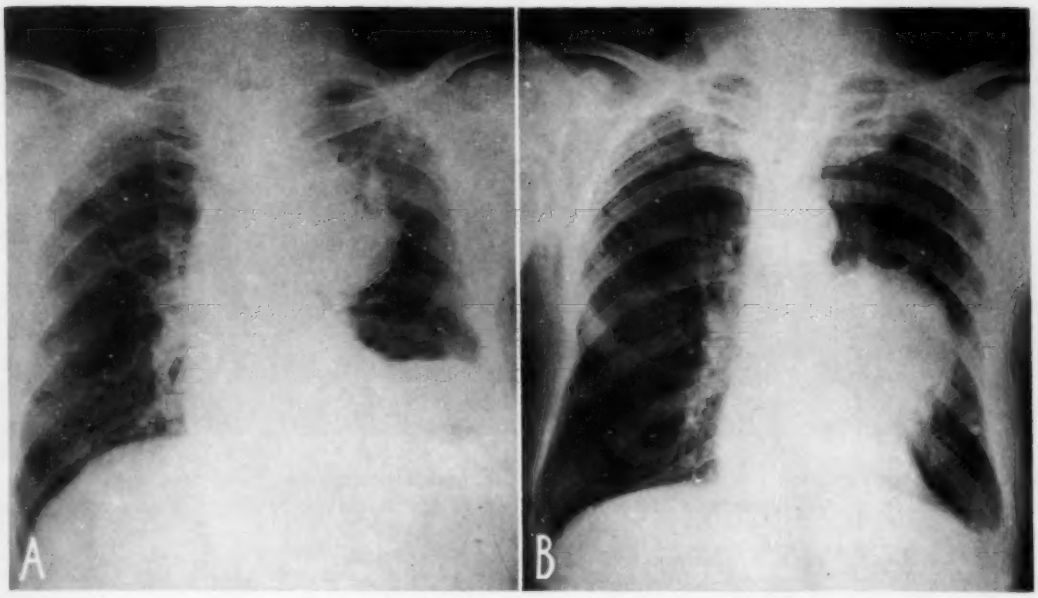


FIG. 3. *A* (Case XV, Table 1). The mass in the medial aspect of the left upper lung field was aspirated under roentgenoscopic guidance and smears and sections of clot of the material were reported as "carcinoma." Bronchoscopy was entirely negative.

B (Case X, Table 1). The mass in the left lower lung field and hilar region was aspirated under roentgenoscopic guidance and histologically diagnosed "carcinoma."

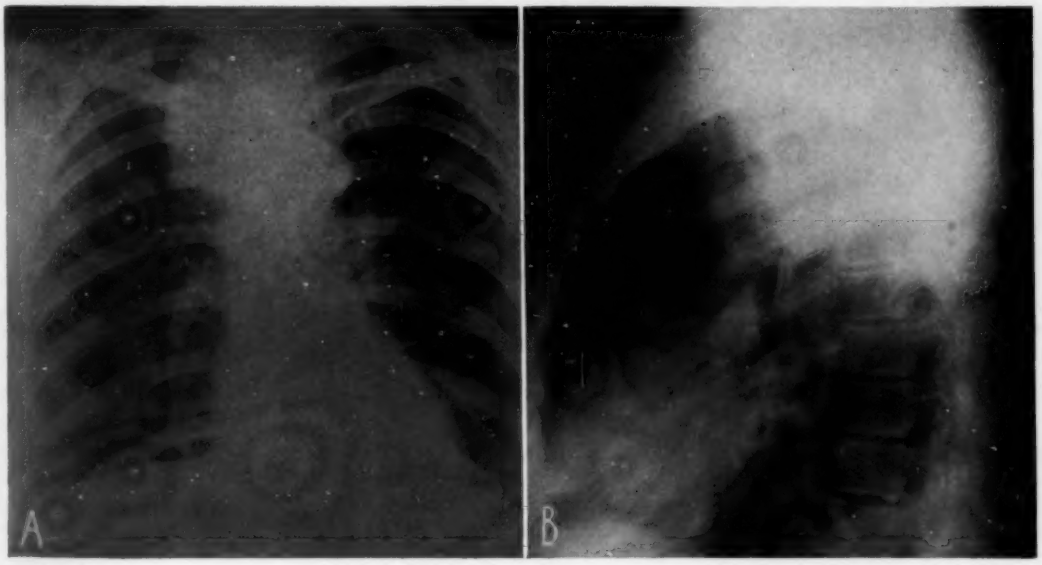


FIG. 4. *A* and *B* (Case XVIII, Table 1). The mass extending into the right upper lung field from the mediastinum has a perfectly smooth outline and does not pulsate. In the lateral projection (*B*) this mass lies in the posterior mediastinum and displaces the trachea slightly forward. In an attempt to verify the clinical and roentgen diagnosis of a mediastinal substernal thyroid an aspiration biopsy was performed under roentgenoscopic guidance and an abundance of normal thyroid tissue was obtained. In this case the approach was made posteriorly through the fourth interspace in the posterior scapular line thus avoiding possible injury to the azygos vein.

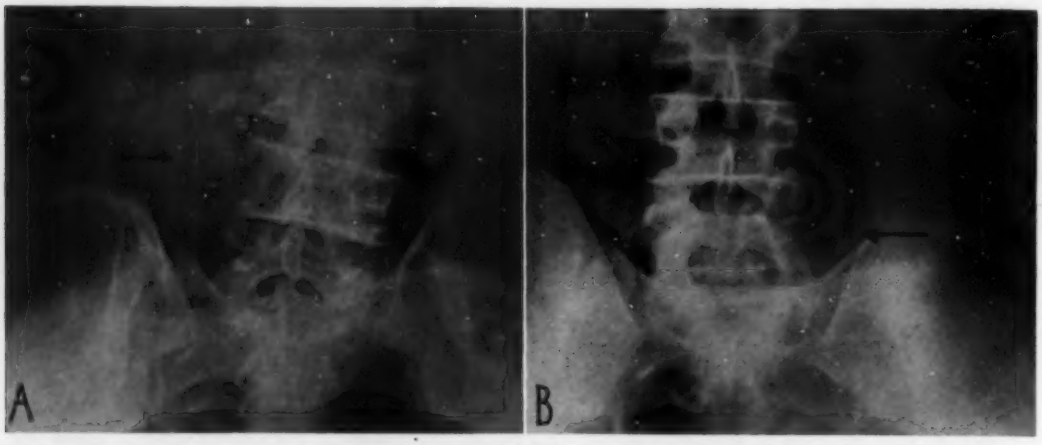


Fig. 5. *A* (Case III, Table II). The destructive lesion in the right transverse process of the fourth lumbar vertebra was aspirated under roentgenoscopic guidance and the smears were reported "metastatic carcinoma."

B (Case I, Table II). Similar lesion in the left transverse process of the fifth lumbar vertebra. Smear of the aspiration biopsy was reported "carcinoma."

Fig. 6. *A* (Case II, Table II). For about ten months this patient complained of back pain. She had been seen by a number of physicians and at several clinics and had been given various medications and treatments, including a body cast, without relief. The roentgenogram of the lumbar spine on admission to Memorial Hospital revealed the destructive lesion in the left pedicle of the third lumbar vertebra (indicated by arrows). The roentgen diagnosis of metastatic carcinoma was confirmed by aspiration biopsy performed under roentgenoscopic guidance. The aspirating needle was inserted through the back above the transverse process of the third lumbar vertebra and was angulated obliquely mesad and caudad. This direction permitted the needle to pass over the transverse process and enter the pedicle. Incidentally the primary focus was an adenocarcinoma of the thyroid removed ten years previously.

B. This patient complained of pain in the left leg and hip. The roentgen examination revealed a small area of radiolucency on the dorsal aspect at the junction of the head and neck of the femur (indicated by arrows). The material obtained by the aspiration procedure performed under roentgenoscopic guidance was reported as "carcinoma." The aspirating needle was inserted through the lateral aspect of the thigh above the greater trochanter. By adducting the leg medially the lesion was satisfactorily exposed and after ascertaining roentgenoscopically that the needle was in the lesion, the aspiration was performed.

the needle is realigned and its position rechecked.

For the aspiration of bone tumors not readily localized by ordinary physical examination, the site of intended puncture and the proper direction of needle is determined by a careful roentgenographic and roentgenoscopic study.

In all of the bone cases aspirated, adequate tissue was obtained to permit of positive histological diagnosis. In Cases I, II and IV (Figs. 5*B*, 6*A* and *B*) roentgenoscopic aid was probably essential in locating the small deep-seated lesion with the needle. These three tumors were all about 2 to 3 cm. in diameter.

Regions such as the head or neck of the femur or the pedicle or a portion of a body of a vertebra are difficult of approach even under roentgenoscopic guidance. An attempt to aspirate any such area blindly would be an uncertain procedure accompanied by unnecessary trauma and pain. Under roentgenoscopic guidance aspiration biopsy of these regions is a safe and exact procedure.

It should be emphasized that aspiration biopsy under roentgenoscopic guidance should not be performed under continuous roentgenoscopic observation. After the site of intended puncture has been selected, the needle is advanced under direct vision by the red light and then its position is checked from time to time by roentgenoscopy.

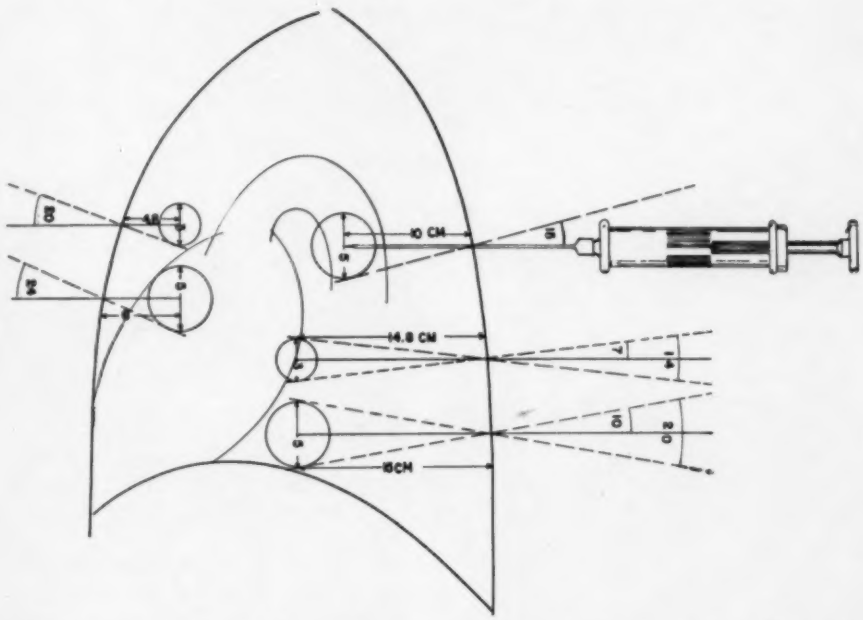


Fig. 7. This lateral chest diagram indicates the difficulties of performing an aspiration biopsy on small and deep-seated lesions. A 5 cm. mass situated at 6 cm. from the skin surface has a permissible angle of deviation of 24°, at 10 cm. 15° and at 15 cm. only 10°. And this presupposes that the exact center of the tumor is carefully projected and localized on the skin surface. It is only rarely possible, however, to localize the exact center of a tumor mass on the skin surface, and even then any slight accidental moving of the patient will change the center on the skin surface. A mass 3 cm. in diameter has an angle of deviation of only 9° at 10 cm. and only 6° at 15 cm. This readily explains how easily either a small mass or one located at more than 10 cm. from the surface may be missed by the aspirating needle, unless the procedure is performed under roentgenoscopic guidance.

INDICATIONS

Roentgenoscopic guidance is not indicated in the average aspiration biopsy in which the tumor can be sufficiently well located by ordinary physical examination and roentgenographic study. The procedure is not necessary even in lung tumors if

peripherally situated and capable of adequate localization by a roentgenographic examination. Similarly, large tumors in bones do not ordinarily require roentgenoscopy for aspiration biopsy.

The indications for aspiration biopsy under roentgenoscopic guidance are:

1. *Tumors in obscure locations*, such as the hilar regions, mediastinal and juxtacardiac portions of the lungs, anterior and posterior mediastinum, pelvis, transverse processes, pedicles and vertebral bodies or the head or neck of the femur, are difficult to approach without roentgenoscopic guidance.

2. *Tumors less than 5 cm. in diameter* are frequently missed when aspirated without roentgenoscopic aid and especially if situated at a considerable distance from the surface. On the other hand, large tumors in the lungs, mediastinum or pelvis very often can be localized from clinical signs and a roentgenographic examination and may be aspirated without roentgenoscopic guidance.

3. *Tumors situated at depths greater than 10 cm.* are difficult to localize properly on the skin surface and the operator is never certain of the position of the aspirating needle in respect to the lesion. For these reasons these tumors are most frequently missed unless the aspiration biopsy is performed under roentgenoscopic guidance. A large tumor (over 5 cm.) may be deeply situated and still can be sufficiently well localized from the roentgenograms so that the aspiration biopsy can be performed without roentgenoscopic aid. A tumor 5 cm. in diameter and at 10 cm. from the surface, however, has an angle of permissible deviation of only about 15 degrees and this presupposes that the exact center of the

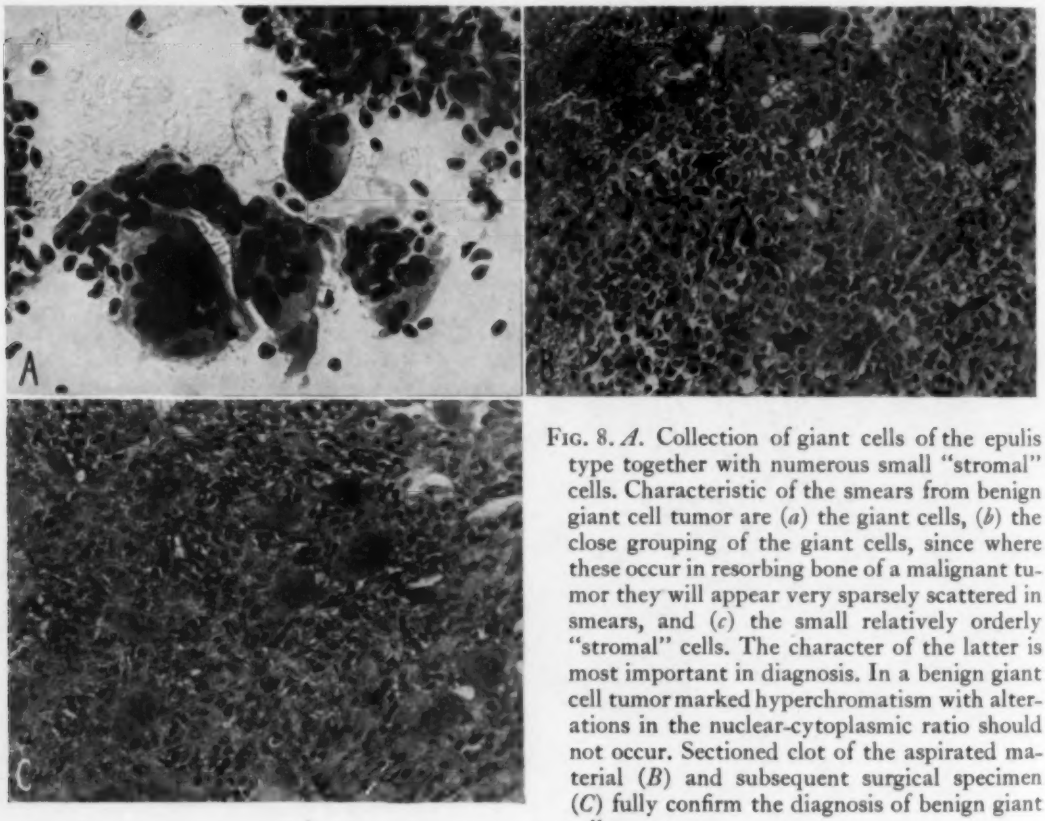
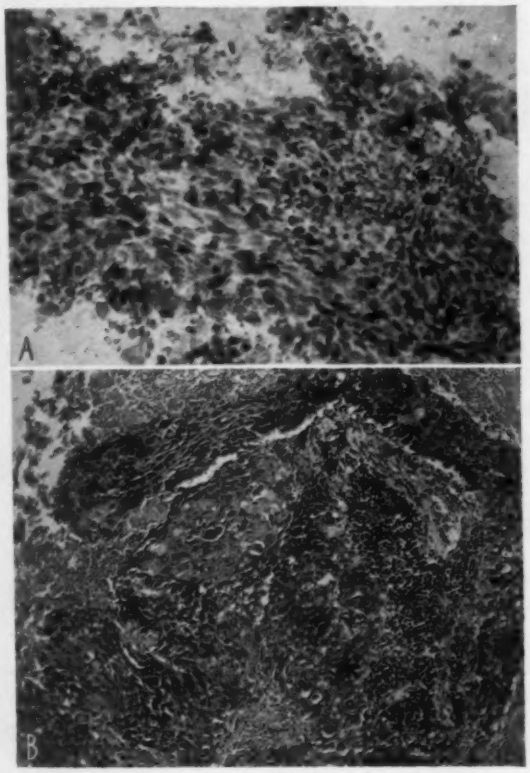


Fig. 8. *A*. Collection of giant cells of the epulis type together with numerous small "stromal" cells. Characteristic of the smears from benign giant cell tumor are (*a*) the giant cells, (*b*) the close grouping of the giant cells, since where these occur in resorbing bone of a malignant tumor they will appear very sparsely scattered in smears, and (*c*) the small relatively orderly "stromal" cells. The character of the latter is most important in diagnosis. In a benign giant cell tumor marked hyperchromatism with alterations in the nuclear-cytoplasmic ratio should not occur. Sectioned clot of the aspirated material (*B*) and subsequent surgical specimen (*C*) fully confirm the diagnosis of benign giant cell tumor.

tumor is carefully projected and localized on the skin surface. Under the same condition, such a mass at 15 cm. has an angle of deviation of 10 degrees, and at 6 cm. 24 degrees (Fig. 7). On the other hand, a 3 cm. mass at 10 cm. has an angle of deviation of only 9 degrees and at 15 cm. only 6 degrees.

4. *Tumors in close proximity to important vital structures* such as the large vessels, esophagus or heart should always be aspirated under roentgenoscopic visualization.



G. 9. *A*, smeared material from a suspected lung cancer; *B*, section of clot from same material. From smear alone the tumor can seldom be classified. Oftentimes fully developed squamous pearls may be found and a diagnosis of squamous carcinoma is therefore possible. This is obviously true of the sectioned clot from this aspiration although from the smear alone one could only say that the lesion was a malignant tumor.

CONCLUSIONS

The technique of aspiration biopsy under roentgenoscopic guidance is described. This procedure is reserved for the difficult cases in which the tumor is in an obscure location, or of a small size (less than 5 cm. in diameter), or situated at a depth greater than 10 cm. from the surface or in close proximity to important vital structures. The visualization and guidance of the needle into the tumor by roentgenoscopy has given the operator greater confidence and has made possible the aspiration of tumors in the vicinity of important vital structures with greater assurance and safety than has heretofore been possible. This has resulted in the establishment of an early diagnosis in these cases and has enabled the immediate institution of treatment, which is of prime importance in cancer.

I acknowledge indebtedness to Drs. L. F. Craver, B. L. Coley and H. E. Martin for their cooperation and interest in this work.

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DISCUSSION

Dr. Hayes E. Martin, New York City. When one fails to obtain tissue from deep-seated tumors by aspiration, there is always a question as to whether or not the point of the needle has actually entered the tumor.

This doubt seldom arises with superficial palpable tumors. If, however, the tumor is small, say 2 or 3 cm., and lies at a depth of several centimeters, the doubt as to whether one can find such a tumor with the point of a needle is so great that an attempt at aspiration biopsy may not be considered worth while. By the technique which Dr. Blady has developed, these

difficulties are largely overcome, and by his experiences in our clinic, he has demonstrated to our satisfaction that these deep-seated tumors may be successfully aspirated.

It should be remembered that in many of these deep-seated tumors the diagnosis cannot be made except by some such means as aspiration biopsy, because there is no other justifiable means of obtaining tissue.

I have nothing to add to Dr. Blady's description of technique, except to emphasize again the importance of such details as the position of the patient in front of the roentgenoscope and the suspension of the arm above the head. These measures are of great importance in good technique.

It has been my impression from hearsay and from discussing aspiration biopsy with individual clinicians that this procedure has not met with universal success. If a histologic diagnosis cannot be submitted, the clinician usually blames the pathologist for his unwillingness to perfect himself in the interpretation of aspirated material. I believe that the failure may often be attributed to the clinician who either does not obtain tissue suitable for diagnosis or does not properly care for it or prepare it so that it may be correctly stained afterward.

Dr. R. Lavine, Syracuse, N. Y. I would like to ask Dr. Blady how he avoids injury to intervening structures or organisms in obtaining these biopsies.

Dr. Blady (closing). I wish to answer Dr. Lavine's question by stating that we minimize the possibility of injury to important structures by performing a thorough preliminary roentgenoscopic and roentgenographic study of the region and surrounding area to be aspirated and by carefully selecting the site for the introduction of the aspiration needle. In the cases in which the tissue to be aspirated is in the neighborhood of vital structures, roentgenoscopic guidance is indispensable and extreme care is exercised in the advancement and manipulation of the needle.

We perform aspiration biopsies on all of the suspected lung tumors in which tissue sufficiently diagnostic of the condition is not obtained on bronchoscopy. As stated before, not all of these cases are aspirated under roentgenoscopic guidance.

The aspiration needle is inserted directly into lung tissue. On many occasions bronchi are pierced as is evidenced by air drawn into the syringe. Frequently blood is drawn into the syringe indicating perforation of a blood vessel. Usually all of the patients expectorate small quantities of blood for a period of twenty-four to forty-eight hours.

Before performing an aspiration biopsy we attempt to reassure the patient and obtain his cooperation by explaining the steps of the procedure. This usually dispels all apprehension and further relaxation is then obtained by giving him a quarter of a grain of morphine sulfate about one-half hour before the aspiration procedure.

As the majority of these patients are ambulatory they are advised to have a relative or a friend accompany them to the hospital. After the aspiration biopsy the patient is kept quiet in the recumbent position for an hour or two and then discharged home with the advice to remain at rest, preferably in bed, for the next twelve to twenty-four hours.

As Dr. Martin pointed out, this procedure to date has been accepted reluctantly and skeptically simply because of the fact that the histological diagnosis is sometimes dependent on the evaluation of a small group of smeared cells. The illustrations (Figs. 8 and 9) comparing the smear, section of clot of the aspirated material and section from the surgical specimen, I am sure, will help to point out that a histological diagnosis of carcinoma can be made in a great many cases from simple aspiration smears.

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THE REMOVAL OF LIPIODOL AFTER MYELOGRAPHY

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INASMUCH as so many spinal cord conditions, including extramedullary tumors on the roots of the spinal nerves as well as herniated intervertebral discs, do not manifest themselves by a clear clinical picture, the use of lipiodol in establishing or ruling out such a suspected diagnosis is entirely reasonable. However, it has been extremely difficult to convince many orthopedists and neurosurgeons that such an examination is justified because it is admitted that it causes a mild aseptic meningeal reaction, and no adequate technique for the removal of this substance from the spinal canal has been adopted.

In order to overcome this reluctance of those interested in this particular examination, the literature was searched early in 1937 for accounts of the removal of opaque substances and it was found that Lucherini,* of Italy, had published an account of lipiodol removal. This was the only reference that could be found at that time. Only two or three salient points in his article need be mentioned. First, he is convinced that all opaque substances, and especially thorotrast, cause a mild aseptic meningeal reaction. Second, his technique for removal is the insertion of a small trocar through the skin, muscles, ligaments and bones into the most dependent portion of the spinal sac. Third, the roentgenograms taken afterward do not show a complete removal.

It was determined that should an opportunity arise a small incision, under local anesthesia, with a drill hole in the base of the sacrum, would be tried. In September, 1938, a suitable case was admitted to the Good Hope Hospital Association Clinic. The patient was a colored boy who had been a tumbler and who also had had typhoid fever. He suffered from low back pain which radiated down the leg. The third and fourth vertebral bodies were close together because of the presence of either a typhoid destruction of the intervertebral disc or a traumatic herniation of the disc. An air myelography, the results of which were not conclusive, was performed, and subsequently a lipiodol myelography, which indicated no protrusion of the disc from between the third and fourth bodies. After roentgenoscopic examination was done and the roentgenograms were made, the patient was taken to surgery in a sitting position, and under local anesthesia an incision was made over the upper spines of the sacrum, the intraspinous ligament was removed, a one-eighth-inch drill hole was placed in the sacrum and a trocar inserted. No material would flow through the trocar. However, upon removal of the trocar the oily material showed itself flowing like cold syrup. Very little that we could do would hurry it. However, by means of a small probe and allowing the material to run over the wound and into a cup, it was kept flowing until spinal fluid was obtained. The spinal fluid was allowed to run until there appeared to be no more globules of oil in it. The wound was then closed in a routine manner.

The length of time that it took for the lipiodol to run out of the small drill hole was approximately one hour, and consequently the patient suffered considerable pain and discomfort as he was sitting up all of this time. His recovery from this procedure was uneventful, and roentgenograms taken several days later showed at least a 90 per cent removal of the lipiodol. The amount of lipiodol injected was 6.5 cc., and a quantitative estimation from the bloody debris and the spinal fluid showed a recovery of 4.5 cc. The amount lost in this crude removal might easily have been 1 cc.

* Lucherini, T. Sull'utilità diagnostica dell'esplorazione radiolipiodolica endorachidea in speciali casi di nevralgie sciatiche e sul mezzo pratico per togliere dal sacco spinale il lipiodol introdotto. *Policlinico* (sez. prat.), 1936, *43*, 575–584.

FIG. 1. *A.* Lipiodol has been in the spinal canal four years. It is not encapsulated. The example is given as one reason for objection to its use. The medicolegal and non-scientific implications are obvious. (Roentgenogram by Drs. R. G. Taylor and R. T. Taylor, Good Samaritan Hospital, Los Angeles.) *B.* Lipiodol in spine eight years. Now encapsulated, which proves reaction does take place. (Roentgenogram by Dr. L. S. Goin and Dr. J. W. Crossan, Los Angeles Orthopaedic Hospital.) *C.* The case in question. Recurrent root pains on the right and lumbar backache. Anteroposterior view. The disc is altered between the third and fourth vertebrae. *D.* Lateral view. (Roentgenogram by Dr. M. J. Kinney, Good Hope Hospital Association Clinic, Los Angeles.)

in sponges, wound towels, etc. Irrespective of this the result was very satisfactory.

The question of the herniated disc was not absolutely, but reasonably ruled out, and the patient was sent to the orthopedic department for immobilization.

In considering the reason why all of the lipiodol was not obtained it seemed that the amount remaining could easily be explained by the site and size of the drill hole. A larger hole should be used and it should be at the level of the second sacral spine

In speaking to some of my colleagues about this, I found that Dr. Adson at the Mayo Clinic had been removing the lipiodol. The following paragraphs are from a letter in answer to my consequent inquiry:

Have the patient sit upright in a chair for an hour before proceeding with its removal in order that all the lipiodol will be concentrated in the caudal sac. The operating table is then ad-

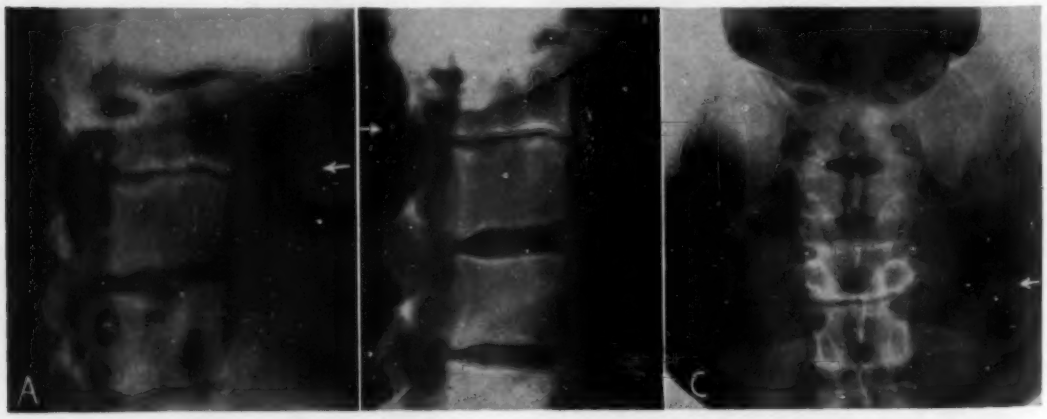

FIG. 2. Air myelograms. Presented upside down. *A.* No apparent protrusion; taken in marked flexion. *B.* No apparent protrusion; taken in marked extension. *C.* Anteroposterior view; no apparent protrusion. (Roentgenograms by Drs. Taylor and Taylor, Good Samaritan Hospital, Los Angeles.)

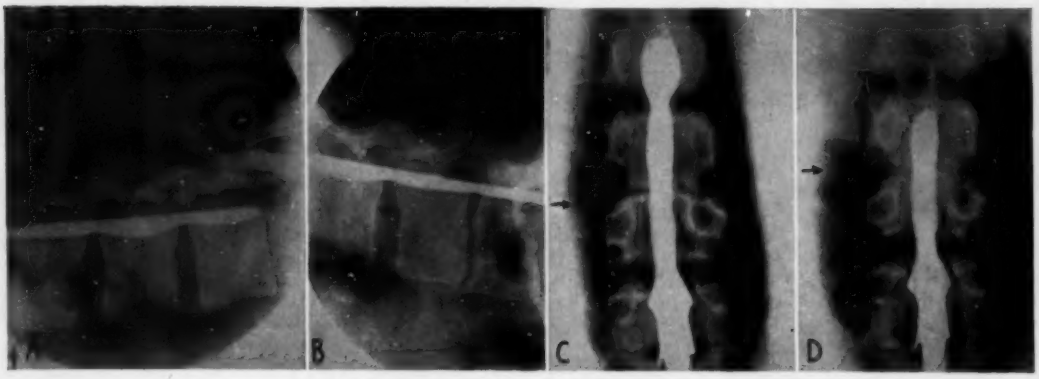

Fig. 3. Roentgenoscopic lipiodol myelography by Drs. Taylor and Taylor. *A*. Lipicdol flowing over suspected area. Lateral view with patient on abdomen. *B*. Picture is reversed, left to right. Further flowing of opaque substance over suspected area. Lateral view with patient on abdomen. *C*. Anteroposterior view of *A*. *D*. Anteroposterior view of *B*.

justed so that the head of the table is much higher than the foot, after which the patient is placed on his abdomen with the feet resting against the foot piece and the hands strapped along the side. In such a position, the lipiodol is constantly kept in the caudal sac.

Under local anesthesia or intravenous sodium pentathol anesthesia, a small incision is made in the dorsal midline opposite the sacrum, corresponding to the second vertebral segment. The fascia and muscle are elevated with the periosteum. The spinal ridge is rongeured away in two bites and the spinal canal is opened with a bone drill, uncovering the caudal sac in an area of about 7 mm. to 1 cm. in diameter. The dura and the arachnoid are incised and the pressure of the cerebrospinal fluid above the lipiodol will promptly force it out of the opening. As soon as the cerebrospinal fluid appears, the head is lowered, the dura is closed, the mus-

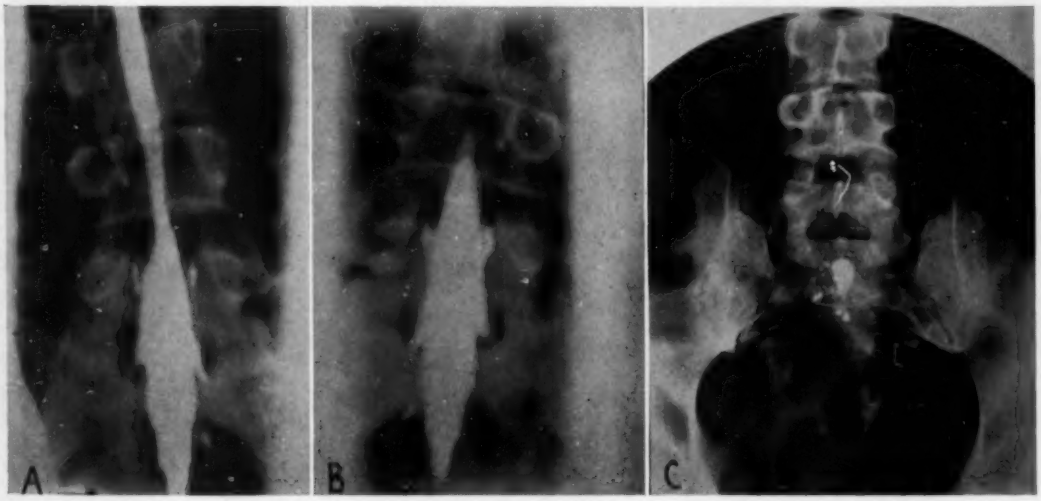

Fig. 4. *A*. Anteroposterior view of opaque substance flowing to caudal dural sac. *B*. Opaque substance in dural sac. *C*. After removal. The $\frac{1}{8}$ inch drill hole was inadequate and the flow of removal too slow. The drill hole is hidden by the opaque substance and is between the two upper sacral spines. A larger hole with a rongeur should be made at the site of the lower spine. (Roentgenograms by Drs. Taylor and Taylor.)

cle and fascial planes closed with heavy chromic reenforced with silk. The skin is closed with interrupted silk sutures.

There is practically no pain connected with the procedure since the opening has been made over the solid part of the sacrum. The wound heals promptly and the patient has been relieved of the lipiodol. In the average patient it is unnecessary to do this, but if lipiodol or any of the radiopaque oils have been used in patients who present indefinite findings and the study proves to be negative, it is probably well to remove the lipiodol. Too often, if the patient continues to have pain, he as well as other doctors may attribute all the pain to the presence of the lipiodol.

It is a useful and worth while procedure and removes one of the major objections to our at present only satisfactory way of performing myelography.

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MEDICAL ECONOMICS OF CHOLECYSTOGRAPHY

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THIS communication is concerned with a routine roentgen examination of the gallbladder by means of cholecystography. The films of this examination were recently presented before a small conference of internists. At the conclusion of the presentation, one of the members of the group requested, as a special favor, that this case be presented at one of the regular monthly meetings of the Philadelphia Roentgen Ray Society. In consequence, the case was subsequently presented before the local Roentgen Society.

There was nothing of immediate interest in the patient's clinical condition. The roentgen examination was an ordinary study of the gallbladder by intravenous cholecystography. In the technique employed, the first roentgenogram of the series was made fifteen hours after the patient received the dye and consisted of a 14″ × 17″ film of the entire abdomen (Fig. 1). It will be noted that the visualized gallbladder is rather inadequately shown overlying the spine, being partially obscured by this bony structure. It is routine practice in this department to see each of the gallbladder films as soon as developed and before the others of the series are made. This enables the roentgenologist to alter the technique as indicated by the result obtained in the first film. Since the gallbladder shadow in this particular patient was obscured by the spine, the technician was instructed to take a second smaller film with the patient slightly rotated so as to project the gallbladder away from the spine. Figure 2 shows how well this was accomplished by this slight maneuver. The gallbladder shadow is now quite easily seen.

One may question the appropriateness of the title of this communication, namely, "Medical economics of cholecystography." During the recent depression, when many institutions as well as individuals found themselves in dire financial straits, much thought was given to the problem of economic salvation. Among the various schemes proposed and now in operation in many cities is the so-called Hospital Insurance Plan. Most of these plans definitely state

FIG. 1. Intravenous cholecystography. Roentgenogram made fifteen hours after the injection of the dye. Gallbladder visualized but obscured by the spine.

that the professional services of the physician are not included; that physicians will continue to charge and collect their fees as in the past. Many such plans, however, include roentgenological and other medical services for which no charge is made to the patient. To circumvent the objection to the inclusion of roentgenological service in Group Hospitalization Plans, someone has proposed that the roentgen examination be divided into two parts: a technical part

Fig. 2. Slight rotation of the patient projects the gallbladder away from the spine.

Fig. 3. Half an ampule of pitressin eliminates gas from the hepatic flexure and for the first time gives a satisfactory view of the gallbladder and reveals a negative shadow indicative of a gallstone.

under the direction of the hospital and to be included in the Insurance Plan without additional charge to the patient and a second or professional part consisting of interpretation of the roentgenograms by the radiologist when requested by the clinician in charge of the patient. For this service the radiologist would submit his own charge. Radiologists immediately recognized that this plan was both unwise and impractical, realizing that medical supervision of the

Fig. 4. After the fatty meal the gallbladder is reduced in size. The negative shadow of the gallstone persists.

technical part of the roentgen examination is an absolute essential in the intelligent application of the roentgen ray to medical diagnosis.

The case here cited is an excellent example of the necessity of medical supervision of roentgenological examinations. Had this gallbladder examination been conducted in a routine manner by a lay technician all of the films of this series would have shown the gallbladder superimposed upon the spine and thus a satisfactory view of this organ would not have been obtained.

Although the simple expedient of slightly

rotating the patient had given better visualization of the gallbladder, the result was still not entirely satisfactory. In Figure 2, it will be noted that the gallbladder is partially obscured by gas in the adjacent colon. Half an ampule of pitressin was ordered for the patient with instructions that a third film be made one hour after the injection. Figure 3 shows the result obtained by this procedure. The gas has been eliminated and for the first time one obtains an unobstructed view of the gallbladder and in addition there is shown a negative shadow, indicative of a moderate sized gallstone. A fatty meal was then ordered for the patient and a fourth film made one hour later (Fig. 4). This shows that the gallbladder is capable of emptying and still reveals the outline of the gallstone. Operation subsequently confirmed the roentgen diagnosis.

It can readily be seen that without careful medical supervision of this examination it would have been practically worthless. The gallbladder would have been inadequately visualized and the gallstone missed entirely. We have encountered many similar experiences so that it has been found necessary as well as advantageous to conduct many of the more or less routine roentgen examinations in this manner. In addition to cholecystography, intravenous urography, encephalography, ventriculography, certain selected head, sinus and traumatic cases are conducted in a similar manner, the "wet films" being viewed by a radiologist, while the patient is still in the department. Additional films with modifications of the standard technique are made as indicated. This has materially added to the value of many roentgen examinations and has made it possible to give a definite diagnosis in cases that otherwise would have been reported as negative or uncertain. This practice leaves little doubt that intelligent roentgenology is impossible without the supervision of a competent radiologist.

FIBRIN BODIES*

CASE REPORT

By CLINTON G. LYONS, M.D.
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A WHITE male, aged forty-six, was admitted to the U. S. Veterans' Hospital at Hines, Illinois, for treatment of pulmonary tuberculosis involving both upper lobes. An artificial pneumothorax was induced before admittance to this institution and a good collapse was obtained of the right lower lobe. A heavy shadow of abnormal density, suggestive of thickened pleura and fibrosis, was seen covering the right upper and middle lobes. An annular shadow or cavity, measuring 4 cm. in the transverse diameter and 3 cm. in the vertical diameter, was revealed in the first anterior interspace and behind the second rib, in the region of the nipple line. The fibrosis and strong bands of adhesions attached to the chest wall prevented the upper and middle lobes from collapsing. These bands of adhesions seemed to have their strongest anchorage in the second anterior interspace and opposite the region of the fifth dorsal vertebra. There was no evidence of fluid in the pneumothorax cavity. The dome of the diaphragm was somewhat depressed. The costophrenic angle was deep, acute and clear.

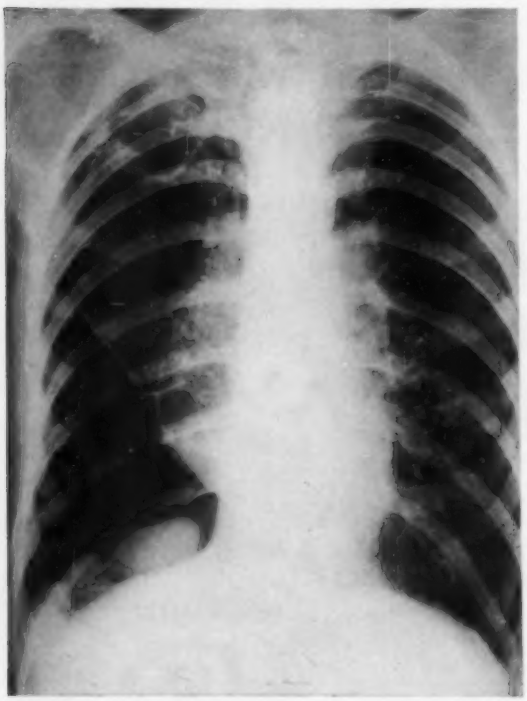

Fig. 1. Fibrin bodies resting on dome of diaphragm.

The roentgen findings of the left chest showed considerable infiltration of the upper lobe which was characteristic of tuberculosis. The diaphragm was smooth. The costophrenic angle was deep, acute and clear, displaying no definite evidence of fluid, adhesions or thickened pleura.

The silhouette or cardiac image at 2-meter distance was of normal size, shape and position for the type of chest possessing it; borders were regular in outline and measurements were not accentuated, showing no definite roentgen evidence of organic disease.

A pneumothorax was seen occupying the entire right lower lobe which contained four oval or opaque bodies measuring approximately 4 by 5 cm. (Fig. 1.) These oval bodies rested on the dome of the diaphragm and, during roentgenoscopic examination in the upright position, extended from the costophrenic angle to the right border of the spine. They changed position freely upon movement of the patient, and when the patient coughed, these bodies were observed to jump. In the Trendelenburg position, these opaque bodies left their anchorage on the dome of the diaphragm and crept slowly along the pneumothorax cavity to the roof of the collapsed lung area. In the prone position, the oval bodies scattered over the pneumothorax area, and at one time they assumed a stacked or chain-like appearance (Fig. 2).

The character of the fluid inhabiting the pneumothorax is, at present, unknown but it is believed to have been blood. In all the other

* Published with the permission of the Medical Director of the Veterans' Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the author.

cases reported they were probably serofibrinous and not purulent, since purulent exudate gives rise to symptoms which call for immediate evacuation, and surgical treatment was not instituted. No surgery was resorted to in this case. If flakes of fibrin were present in the fluid, it is to be expected that they might coalesce to form a homogeneous mass which once formed would act as a nucleus for the deposit of additional fibrin. A similar process is sometimes encountered in hydropneumothorax or empyema, where fibrin clots form masses of sufficient size to block drainage.

In 1922, Fleischner[1] first reported the presence of opaque bodies which he observed floating in the pleural exudate in an artificial pneumothorax cavity. He believed that the bodies were due to fibrin, similar to the smaller flakes of fibrin which are commonly seen in pleural exudate. In 1925, Düll[2] reported 3 cases. He was of the opinion that the opaque bodies were blood clots formed by hemorrhage due to trauma to the intercostal artery during the induction of air. Maendl[3] reported one case following an exudate. Poindecker[4] also reported one case. Stöffel[5] reported a case. An autopsy was performed on a case reported by Wischnowitzer[6] who found that the bodies were composed entirely of fibrin.

The ultimate fate of these fibrin bodies is, at present, undetermined. They have been known to exist in the pleural cavity for four and one-half years. In the course of time they get smaller, probably from shrinkage of the fibrin of which they are composed. It is hardly expected that they will disappear completely since they are detached and subject to free movement in the pleural cavity and therefore are not exposed to the ordinary process of resolution. One can only speculate as to their fate in case the lung re-expands.

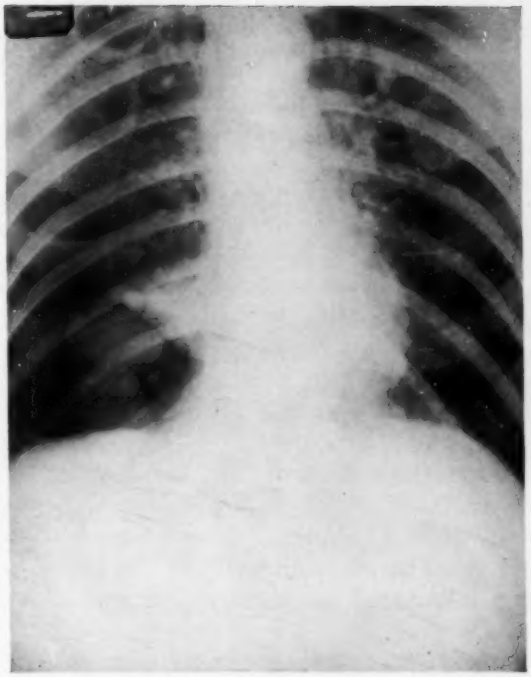

Fig. 2. Roentgenogram taken in the prone position shows that the fibrin bodies have left their anchorage on the dome of the diaphragm and assumed a stacked appearance.

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THE ROENTGEN TREATMENT OF PRIMARY INOPERABLE CARCINOMA OF THE BREAST*

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IN THIS paper we are reporting a study of 212 patients suffering from primary inoperable carcinoma of the breast who were treated in the Section on Therapeutic Radiology of The Mayo Clinic in the years 1925 to 1937 inclusive.

The study is concerned with the treatment of primary inoperable lesions only and, as such, implies no hope for curative results. The great majority of the patients presented such an advanced stage of inoperable cancer that palliative results alone were the best that could be expected. The term inoperable carcinoma of the breast is restricted to primary inoperable cases, except for a few cases which had been treated incompletely by means of escharotics. That is, this group includes cases of ulcerated carcinoma with or without fixation to the thoracic wall, carcinoma with cutaneous metastatic involvement, carcinoma which might have been treated locally by surgical methods but which was accompanied by extensive metastases to the axillary and supraclavicular lymph nodes, the viscera, or the skeletal structures, and carcinoma in the presence of other serious organic disease which would unjustifiably increase the surgical risk.

TABLE I

KNOWN DURATION OF PRIMARY INOPERABLE CARCINOMA OF THE BREAST PRIOR TO TREATMENT

Duration	Number of Patients	Per Cent
Less than 6 months	59	28
6 to 12 months	57	26
1 to 2 years	36	17
3 to 5 years	36	17
More than 5 years	16	8
Unknown	8	4

The duration of the carcinoma of the breast prior to the commencement of roentgen therapy appeared to vary from one month to sixteen years. The majority of patients stated that they had noticed the lump in the breast for one year or less. However, many had been aware of a mass in the breast for three years or more (Table 1). This wide variation in the alleged duration of the tumor in the breast prior to roentgen therapy may be attributed to various factors other than the absence of signs and symptoms which might have attracted the patient's attention to a lesion of the breast. For example, in 7 instances the physicians' advice was not followed by the patient at a time when the lesion might have been treated surgically with a reasonable hope of obtaining a cure. Nine patients were considered to have been advised incorrectly by their physician on the basis of his mistaken diagnosis. Twelve patients were prevented from receiving timely adequate surgical or roentgen therapy by undergoing treatment with escharotic paste.

Of the 212 patients, only 2 men were found to have malignant disease in the inoperable stage. One of these patients had noticed a lump in his breast for seven years and the other had noticed a lump for six months.

The age groups included those from the third to the ninth decades, the greatest number of cases (31 per cent) occurring in the sixth decade (Table 11).

The right breast was involved in 91

* Read at the Thirty-ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 20–23, 1938.

cases, the left in 105 and both breasts were involved in 16 cases.

In an attempt to ascertain in what situation in the breast the primary lesion was most frequently located, the breast area was divided into a central zone and superior, inferior, medial and lateral quadrants. In 55 cases (26 per cent) the entire breast was involved without evidence of a definite local lesion. The upper outer quadrant was the site of the primary lesion in 64 cases (30 per cent), the upper inner quadrant in 9 cases (4 per cent), the lower outer quadrant in 17 cases (8 per cent) and the lower inner quadrant in 11 cases (5 per cent). It will thus be apparent in this group of inoperable carcinomas of the breast that the central zone and the upper outer quadrant are the most frequent sites of the primary lesion.

The size of the tumor in the breast when the patients first attended for treatment varied greatly and did not necessarily influence the surgeon's decision as to whether or not the lesion was operable. The smallest inoperable lesion found was approximately 6 mm. in diameter and was proved by biopsy to be a Grade 4 adenocarcinoma, on a basis of 1 to 4. This patient was considered to have an inoperable lesion because of extensive supraclavicular metastasis. No other primary lesion or metastases were demonstrable after a very thorough examination. It was often impossible to determine the size of the largest lesions because many of them were accompanied by mastitis and ulceration. However, tumors larger than 5 cm. were frequent.

Biopsy was not often considered to be an aid in making the diagnosis or outlining the treatment for these patients. It was performed in 17 instances. In each case the tissue was reported as Grade 4 adenocarcinoma (Broders' classification).

Metastatic lesions involved the skin, the axillary lymphatics, the supraclavicular lymphatics, the lungs, the abdominal viscera and the skeletal structures in the great majority of patients when they first attended for treatment. These metastases often determined the question of the operability of the mammary tumor. Metastatic lesions involved the skin in 109 cases, the axillary lymphatics in 194 cases, the supraclavicular lymphatics in 116 cases, the lungs in 22 cases, the abdominal viscera in 20 cases and the skeleton in 34 cases. The inflammatory type of lesion was encountered in 5 patients and this condition by itself was generally considered to be inoperable. In 6 patients, what was considered to be a second concurrent and independent primary malignant neoplasm was discovered. In 4 patients the second tumor was in the uterus; in the other 2 it was in the stomach and large bowel respectively. One of these patients presented an unusual history. Having had a radical amputation of the right breast on account of carcinoma twenty-three years previously, she had remained in apparently good health until a short time before presenting herself at The Clinic because of irregular vaginal bleeding. At this time it was found that she had a carcinoma of the cervix uteri and also a carcinoma of the left breast. She was still in apparently good health four and a half years after treatment. The tissue from the original lesion removed twenty-three years previously was reviewed and was found to be a Grade 2 adenocarcinoma.

Three patients were pregnant at the time they came for treatment. Many others were found to have various organic diseases

Table II

AGE DISTRIBUTION OF PATIENTS SUFFERING FROM PRIMARY INOPERABLE CARCINOMA OF THE BREAST

Age, Years	Number of Patients	Per Cent
20 to 29	2	0.9
30 to 39	17	8.0
40 to 49	48	22.6
50 to 59	66	31.1
60 to 69	57	26.9
70 to 79	21	9.9
80 to 89	1	0.5

such as severe diabetes, active pulmonary tuberculosis, severe cardiac disease and chronic myelogenous leukemia.

From a consideration of the general condition of these patients, who were mostly feeble or debilitated women over fifty years of age with advanced lesions, it is obvious that treatment by radical or intensive radiotherapy was not advisable. Rather, an effort was made to alleviate the patient's discomfort, to retard further dissemination of the neoplasm as far as possible and to prevent ulceration or hasten the healing of areas already ulcerated by careful and judicious roentgen therapy.

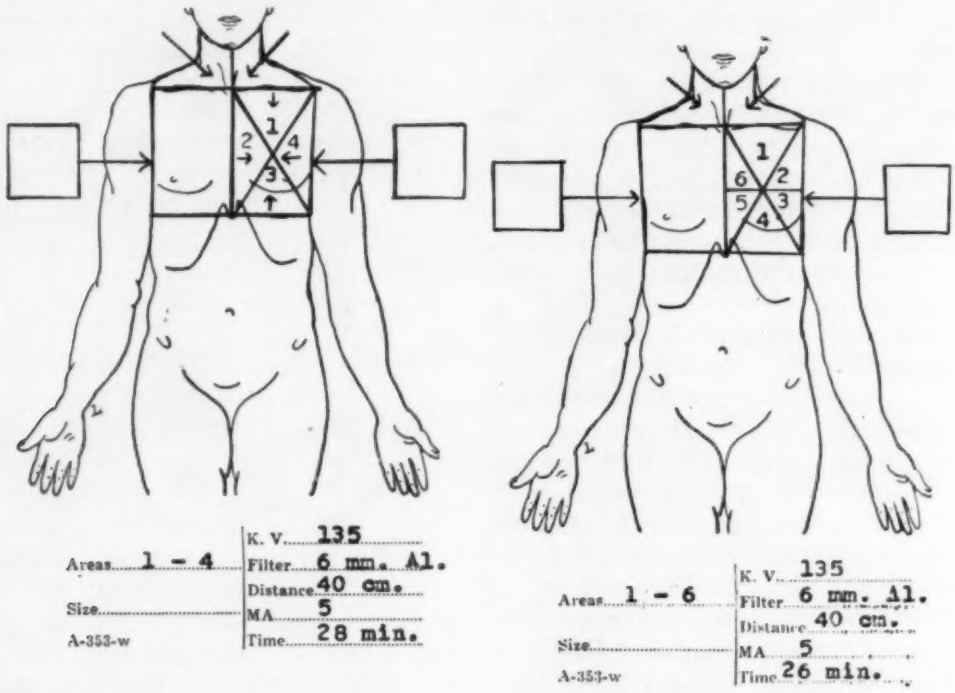

FIG. 1. The distribution of the fields of treatment. It may be noted that each area receives a suberythema dose of roentgen rays; the greater the number of portals the greater is the reduction of the dose of each (see Leddy[4]).

The technical factors used in treatment were 135 kv. (peak), 5 ma., 40 cm. skin-target distance, and 6 mm. of aluminum filter, as a rule. The arrangement of the fields was governed by the needs of the individual patient. Wherever possible, the lesions were treated by the method of "multiple converging beams," described by Desjardins. This method has continued to prove itself a very effective procedure, not only as applied particularly to inoperable carcinoma of the breast, but also in the treatment of many other conditions. We continue to doubt the advisability of using 200 kv. in treating the average case of inoperable carcinoma of the breast, because by its use the likelihood of pleuropulmonitis is increased, particularly if converging beams are used or if the treatment is repeated. Further, the "reaction" from high voltage treatment is generally too great for the well-being of most of these patients. Then too, it was not expedient clinically, nor in fact was it sensible, to apply in roentgen treatment anything more than moderate doses to patients of this type. Since, in our experience, treatment with rays generated at 200 kv. is in general harder on patients than is treatment with rays generated at moderate voltage and since the results in this type of

lesion do not seem to be better with the former technique, we prefer to use moderate voltage treatment for all but exceptional cases.

As shown in Figure 1, the anterior hemithorax is divided into from four to six sectors by diagonal and transverse lines, so that each sector is centered over the tumor in the breast. The central ray is then directed toward the tumor through each sector.

Baird and Leddy have shown that the "dose" delivered through a triangular field formed, for example, by a diagonal line across a square or a rectangle, is not half the dose that would be delivered to the corresponding square or the rectangle but about 70 per cent of that dose. The use of multiple triangular fields makes it possible, therefore, to deliver a greater dose to the breast lesion than can be given to it through the customary square or rectangular fields.[5]

In addition to the fields over the breast, one or more supraclavicular and axillary areas are treated, and other metastatic lesions as may be indicated. One or two fields are treated daily and the course of treatment is completed in successive sessions in from three to ten days, depending on the number of fields to be treated and on the constitutional reaction of the patient. Most patients can tolerate the treatment of only one field a day. Only exceptionally has a true protracted fractional treatment been attempted and the results in these few cases are inconclusive. Each area receives a dose of about 500 to 550 r, as a rule. A similar course of treatment is given in a second month and again in a third month. After a rest of three months, further treatment is given from time to time as may be indicated, usually once in six months, even though the lesion is quiescent clinically. We have given as many as ten courses of treatment to one patient over a period of five years. This patient had no pulmonary changes and only scattered telangiectases. This type of treatment causes very little discomfort and inconvenience to the patients in proportion to the relief it usually affords them. To achieve the best palliative results, our experience has been that at least three consecutive courses of treatment are necessary. We have never seen injury of the lung and only mild skin changes after three such courses.[2]

Of the 212 patients, 82 were considered to have had adequate roentgen therapy because they had completed three such monthly courses and 130 to have had inadequate treatment because for various reasons they did not complete the treatment planned for them. Supplemental treatment with radium packs or needles was given to 38 patients. Radium was used most frequently in the treatment of those patients suffering from metastatic lesions in the skin, which generally are refractory to any method of treatment but which seem to do better after radium therapy. Radium was also used in the treatment of certain patients with metastatic involvement of the supraclavicular lymph nodes.

Additional roentgen treatment was given to 36 patients elsewhere than at The Clinic but the results of these treatments are not known.

The duration of life from the time of the first treatment to the last report was nine years in the longest and nine days in the shortest instance. The latter patient was moribund when first seen and a placebo treatment was given only in the hope of possibly relieving her suffering. The duration of life of most of the other patients after the last treatment is of little statistical value in view not only of the great variation in the duration of the tumors before roentgen treatment at The Clinic but also of the fact that in all of these cases roentgen treatment was used rather as a palliative than a curative procedure.

Since the rest of the patients did not have three courses of treatment, only 82 patients can be considered to have had adequate roentgen treatment. Satisfactory reduction—and in fact complete regression in some cases—of the primary and metasta-

tic lesions was obtained in 82 of them, and in 49 instances definite abatement of pain in addition.

Ulcerated carcinomas occurred in 67 of the entire series of 212 cases. In 19 cases where adequate treatment was given, healing of the ulcer followed in all. In the 48 others reduction of the ulcer and drying of the discharge resulted but the amount of improvement was too indefinite to warrant a positive statement about the value of treatment which, in some cases, was inadequate. Furthermore, in some cases where healing of the ulceration had lasted for a few months, the regression and quiescence of the malignant process was followed by a terminal recrudescence of tumor growth.

In view of the evident benefit obtained by the patients who had received adequate treatment, it seems logical to assume that a considerable number of those patients who received inadequate treatment might have derived more benefit than they actually did if they had completed three courses of irradiation, which seems to be the best therapeutic test of the method. It also seems reasonable to assume that, considering the 48 patients suffering from ulcerated lesions whose treatment was in some cases inadequate or for whom the results were indefinite, the end-result might have been better if the patients had had better treatment and a more complete follow-up. As far as we know, no patient was made worse by the treatment.

SUMMARY

From our experience, based on 212 cases of primary inoperable carcinoma of the breast, we feel that roentgen treatment by the method of "multiple converging beams," is a satisfactory way to produce worth-while palliation in an otherwise desperate clinical situation. Not only is the method entirely without risk to the patient, but also it is technically easy to apply and, if adequately used, produces definite, though temporary, benefit. We know of no other radiologic method of treatment which has produced better results in an adequate series of cases.

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DISCUSSION

Dr. G. Failla, New York City. I find myself in a rather embarrassing position here, having to discuss a clinical paper and not knowing anything about it. However, I can go back to the title of the paper and find something that I can discuss, perhaps, in this method of multiple converging beams.

That is our old friend again, the crossfire method, which should be used wherever it is possible or expedient, so that in this sense I think they are using a good method of treatment at The Mayo Clinic for these lesions.

The next thing I might discuss or refer to is the voltage, 135 kv. and filter of 6 mm. of aluminum. If one wishes to preserve the lungs and damage the tumor which, in most instances, I presume, is rather superficial, that is probably the right voltage and filter to use.

As to the feasibility of applying these multiple and converging beams, I think it is a little difficult to say that the tumor is receiving the radiation from all the multiple beams. The geometric factors are not ideal for this because the tumor is rather superficial and usually the chest is more or less flat. Unless very great care is taken, the crossfiring may be done in the lung. This, of course, is a matter for the clinician in setting up the patient.

In general, I would say that in the type of cases considered here, this method carefully applied is indicated, from the point of view of the physicist.

Dr. Otto Glasser, Cleveland, Ohio. Dr.

Failla has not left much for me to say in the discussion of this paper. One idea, however, did occur to me when I heard Dr. Leddy speak. He has presented a large series of cases which were treated over a period of twelve years with one and the same excellent method. This is a very satisfactory procedure to follow, especially in view of the fact that radiologists now are apt to change their roentgen technique. They follow a certain routine of treatment until they hear from a friend that he uses a higher voltage or something else and very often they feel that this new technique might be much better. If such changes are made, it is always advisable to continue treating similar conditions with the old treatment technique at the same time the new one is used in order to be able to make comparisons of the results obtained.

It is for this reason that I feel that Dr. Leddy's paper is of great value since it presents results obtained with a very satisfactory treatment technique over a large number of years and with a large number of patients.

It should be easy to compare these results with the results possibly obtained by a different treatment technique.

IRRADIATION KERATOSES AND CARCINOMA*

By JAMES J. DUFFY, M.D.
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IT IS with much hesitation that I present this short discussion of the treatment of radiation dermatitis and its sequelae. The treatment of these various manifestations in the skin has received very little attention from the profession. Only those afflicted have been interested. Because of this limited interest, there is little knowledge about the conditions.

Most of those afflicted by the irradiation sequelae are radiologists who have been workers with radium and roentgen rays over a long period of years. This group is not only rather numerous, but the number seems to be increasing. This increase may

FIG. 1. Splitting nail and advanced keratoses in a young radiologist.

be only apparent because I am seeing more victims of the late effects of irradiation. I am also seeing now some lesions in the younger generation of radiologists.

Having had some degree of success in the treatment of these lesions, I have been impelled to give a survey of the methods used. Most of the radiologists who have skin changes accept them as a matter of course. These men may be classified in two groups: those who are optimistic enough to think that the lesions will progress no further; and those who are so discouraged that they have no faith in any procedure. This presentation is intended to awaken the first group from their lethargy, because the earlier lesions will progress, and to offer encouragement to the pessimistic group.

It seems to me that there are those who believe that radiation treatment is suitable for all or most of the effects of irradiation. This is not so. There are definite limitations. In order better to show these limitations, I shall briefly outline the several manifestations and their treatment, emphasizing the treatment of those lesions which are most common, and in which irradiation has been successful. The description of the several manifestations is intended for recognition and not for dermatologic diagnosis.

Most of the lesions that I have seen are the result of testing the old-fashioned gas tubes or of roentgenoscopy; a few have followed the handling of radium or radon. There is no way of distinguishing these effects, except that the more heavily filtered radiation produces a comparatively greater effect on the osseous tissue in relation to the amount of skin effect, but this difference is not marked.

The first changes to be noted following prolonged exposure to radiation is drying of the skin over the dorsum of the hand and fingers; the nails become brittle, and the skin of the fingers over the terminal phalanges is reddened. It is crinkled and this portion of the reddened skin glistens. Later the nail of one or more fingers is roughened, the "ribbing" being in the longitudinal direction of the nail. This "ribbing" may be general or may present itself as one large elevation which splits as it approaches the end of the finger.

The most important care to be given the hands during this stage is the avoidance of further irradiation. The hands should not be unduly exposed to sunlight, nor should they be unprotected in cool or cold

* Read at the Twenty-Fourth Annual Meeting, American Radium Society, St. Louis, Mo., May 15–16, 1939.

weather. Exposure to cold makes the skin changes more marked. The hands should be cleansed with a good grade superfatted soap only, and the skin kept soft by a neutral cold cream or lanolin. This may be applied at bedtime and cotton gloves should be worn during the night.

It is thought by some workers with irradiation that there is some recuperation from the tissue sclerosis following the administration of concentrated liver extract or whole liver powder.

The next stage in the progress of irradiation effect may be the formation of keratoses. Less frequently, a small area denuded of skin appears, 2 to 3 mm. in diameter. From this area exudes a small amount of serum. Slight trauma causes the oozing of blood. Such an area may apparently heal, to be again denuded at some later date. These reddened and denuded areas are the forerunners of keratoses, though the time interval is most indefinite. Occasionally the reddened area progresses promptly to a horny keratosis.

Fig. 2. Keratoses and carcinoma. The little finger was denuded of skin from base to base of nail. Following treatment with the "bulb," it healed in three weeks.

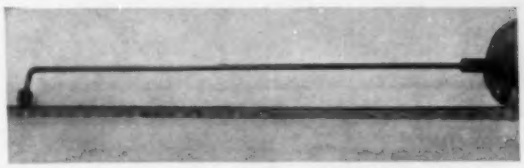

Fig. 3. The "bulb" used in treatment of keratoses and superficial cancer.

This type of keratosis is the most frequent manifestation that is seen. The lesions vary in size from 1 mm. to 1 cm. At first one may feel them, but they are seen only by magnification. The progress of keratoses in the early stage is usually very slow, years sometimes elapsing before there is much change.

There is one rather rare lesion that is seen after prolonged exposure to irradiation. It is the elongated, horny papilloma. This may protrude to the extent of 6 to 8 mm. Peculiarly it seems to be limited to the lower eyelid and the immediately surrounded cheek.

The three types of lesion just enumerated are most amenable to long wave irradiation with the radon "bulb." Such treatment seems paradoxical—however, it produces good results.

The "bulb" consists of a glass sphere, the walls of which are 0.2 mm. thick, into which is collected one day's accumulation of radon from nearly 5 grams of radium. This amounts to 550 to 600 mc. of radon. This sphere of glass containing the radon is placed in a bell-shaped brass container on the end of a handle about 15 inches long. Only alpha rays are filtered out. Therefore, most of the radiation is beta.

Because of the large radon content, the very slight filter of glass only, and the contact application, the time of exposure is extremely short. For the denuded areas, the dosage is 150 to 175 mc-min., each portion of the denuded area being given this dosage. If the area is widespread the individual doses are somewhat smaller because of the cross irradiation. When a keratosis is present the individual dose is increased to 250 to 300 mc-min. It is a striking fact

that even the bulky lesions, that is lesions 2 to 3 mm. in thickness, respond to this lightly filtered irradiation. However, in this type the dose is increased to 400 to 450 mc-min.

The reaction following treatment does not follow the usual course of such treatment. Ordinarily, the irradiation reddening from the above doses appears in five or six days, and subsides in about three weeks. In the cases under discussion, the reaction is delayed for two or three weeks. Even then the reddening is mild. However, the discomfort is moderately severe. These reactions are prolonged two to three weeks, when the keratosis can be picked out of its bed. The skin then appears fairly normal, being of a finer texture than the normal skin of the hand. The denuded areas respond to the smaller doses by quickly becoming dermatized, without discomfort. I have seen a little finger, denuded from base to base of the nail, that was completely healed in three weeks.

The horny papilloma must first be removed at its base. This can be done in most instances by thumb forceps. The base is then treated with the "bulb," the dose being determined by the amount of induration: 200 to 350 mc-min.

There is one observation, made by a few of the radiologists I have treated, that is very hard to interpret. Their observation is that a better result was obtained when the "bulb" had the larger amount of radon content, and the time of exposure was therefore shortened; that is, a "bulb" of 600 mc. for twenty seconds produced a better result than a "bulb" of 200 mc. for one minute. I can neither affirm nor deny this observation, not having seen the progress at frequent intervals, because most of those treated have lived at a considerable distance from me.

These lesions, especially the papilloma and the keratoses, are often treated by electrodesiccation. Such a procedure is not indicated. The delayed healing of an electrical burn is being added to the slowed healing of an already sclerotic region. This combination prolongs indefinitely the final healing. And, during this interval, there is a great deal of discomfort. Electrodesiccation should not be used as a routine in the case of irradiation keratoses.

Another type of irradiation effect, the next stage after the keratosis, is the intradermal carcinoma. This varies in size from 1 mm. to 5 or 6 mm. It has little or no elevation above the surrounding skin. It has little roughening, is not ulcerated, is freely movable with the skin of the dorsum of the hand. Of course, over the dorsum of the fingers, where there is practically no subcutaneous tissue between skin and tendons, there is very limited mobility.

The "bulb" is not adequate for the treatment of these lesions. The intradermal carcinoma of the dorsum of the hand should be excised and the defect closed directly. Over the dorsum of the fingers it may be necessary to fill the defect with a graft. It is sometimes necessary to insert a graft on the dorsum of the hand if the defect is too large to be closed directly. I have found it advisable to treat palmar defects also with grafts. Whenever a graft is required, it must be a full thickness graft, namely, a Wolfe graft, to obtain the best result for a hand. A Thiersch graft is unsuitable for the hand.

A later stage of the keratoses and intradermal carcinoma is the ulcerated cancer. These vary in size according to the stage of the disease. In this lesion, infection plays an important part. The growth extends much more rapidly, probably due to the increased blood supply in what had been sclerotic tissue. Although metastases from roentgen carcinoma are not frequent, such metastases most often occur after infection has been grossly apparent for a period of time.

When the ulcerated cancer is on the dorsum of the hand, it may be possible to treat it with filtered radiation. But such a decision must await the report of the roentgenologic findings as to the condition of the bone. If there is no bony change and there is no atrophy of the subcutaneous

tissues, then irradiation may be tried. If there is any osteitis, wide surgical excision and plastic repair is the method to be employed. Whenever such a lesion is on the dorsum of the finger, especially toward the terminal phalanges, no attempt at irradiation should be made. If the disease is beyond local excision and plastic repair, then the conservative treatment is amputation of the finger. Heavily filtered radiation in adequate dosage will cause necrosis, and tendons more or less promptly, depending on the location. Such carcinoma does at times infiltrate bone, though this is not frequent. Even though the bone is not invaded by cancer, the concomitant infection quickly causes periostitis, and even osteomyelitis. When carcinoma has reached such a stage, it is not conservative to attempt irradiation care. The conservative procedure is surgery, which will eradicate the disease and also relieve the pain.

Fig. 4. Infiltrating carcinoma which requires surgery, Radiation treatment was tried in this case, followed by necrosis, severe pain, necessitating prompt surgery.

radiation osteitis, and most surely prepare the way for an amputation following a period of extreme pain. The combination of infection and irradiation causes destruction of the bone which is accompanied by unbearable pain. It is this stage of disease and this type of treatment which causes the sufferers to become drug addicts. I cannot emphasize too greatly that heavily filtered radiation should not be applied to irradiation carcinoma of the terminal portions of the fingers.

In the more advanced carcinoma of the hand and fingers, there is infiltration into the deeper tissues, involving the sheaths Carcinoma cannot be cured when it has permeated the tissues around tendons.

There occurs at times a marked irradiation osteitis which is consequent upon the prolonged exposure to irradiation. This is not related to the bacterial type of osteitis. There is usually some associated skin change but this may not be severe. Such a bone lesion is unbearably painful. The pain is described as "deep in the bone," "boring" in character. The distribution of the pain is throughout the member, and not limited to the area which shows roentgenologically the definite changes in bony structure.

I cannot discuss the differentiating characteristics of the inflammatory and irradiation changes in the bone. In most instances, they occur together. In either case, the pain is severe,—but I think it worse in irradiation osteitis.

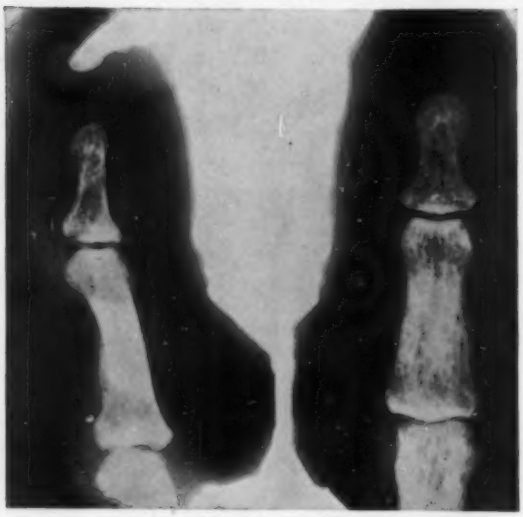

Fig. 5. Roentgen appearance of the combination of irradiation osteitis and bone infection.

The treatment is the same whether the bony change is due to irradiation or to irradiation and infection. Sacrificing the involved member is the only reasonable and humane procedure; and should not be delayed in order to try any form of useless treatment, such as hot compresses, antiseptic solution, anesthetic ointments, or irradiation.

Metastases from cancer following irradiation are not common. There should be no such occurrence if the lesions are promptly and adequately cared for. The lack of metastases is probably due, for the most part, to the more differentiated cells comprising the lesions. Nearly all the pathologic reports show either a fibrocarcinoma or a squamous carcinoma, Grade 1. Rarely is a Grade 2 cancer seen.

The metastases are very radioresistant, and therefore should not be treated with irradiation. The treatment is surgical dissection of the regional nodes when they are involved.

This is a résumé of the procedures to be followed in the care of the several manifestations following prolonged exposure to irradiation. However, I do not feel justified in attempting minute description of the lesions which are so much better known by those who have them, nor is it necessary to discuss detailed technique of treatment. This discussion is presented to acquaint those radiologists having skin changes with the fact that the earlier stages of keratoses may be cured, and that there is no reason to procrastinate in the more advanced stages, when carcinoma is well developed and has become extensive. Many of our confreres can attest to the efficacy of treatment, especially of the keratoses, which comprise the greater portion of all the irradiation dermatitis sequelae.

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THE RADIUM TREATMENT OF PEYRONIE'S DISEASE*

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FIBROUS plaques of the penis were first described, in 1743, by La Peyronie, who was physician to Louis XV. There are almost as many synonyms to designate the disease as there are theories regarding its causation. In the literature it is called fibrous cavernositis, fibrous sclerosis, plastic induration of the penis and primary indurative cavernositis. Cabot aptly depicts it as one of the more common of the rare diseases of the penis, and much interest has been shown in the etiology and treatment. Theories of causation have implicated trauma, gonorrhea, syphilis, gout and arthritis. To date, however, the precise etiology is unknown.

The prominent characteristics of the disease are well recognized. It is known that the induration may appear as a plaque, nodule or cord, and that it is solitary or multiple. The most usual situation is the dorsum of the penis, in the midline near the base of the organ, where the lesion involves the sheaths of the corpora cavernosa and the septum. The urethra and the corpus spongiosum are not affected. The induration is superficial and readily palpable. The skin is freely movable over the lesion and is not tender. Microscopically, the lesion resembles a keloid.[5] It consists of a network of scar-like tissue and elastic tissue, which contains few vessels. In cases in which the disease has been present for a long time, deposits of bone and cartilage are seen.

The symptoms consist of deformity on erection, which may or may not cause pain. This often interferes with sexual intercourse. The condition mainly affects middle-aged or elderly men; it progresses to a certain stage and apparently becomes stationary. Spontaneous recovery occasionally has been reported.

The condition probably is far more common than reports would indicate. In this country 5 cases were reported prior to 1874.[5] In 1928 Polkey said that 549 cases had been reported in the literature.

Treatment has been varied. Fibrolysin, iodides, diathermy, roentgen rays, and surgical removal have been tried, but the results have been reported without great enthusiasm.[2,9] Many reports are discouraging. One or two reports have been encouraging. Kumer and Soiland and Lindberg who used radium therapy, and Rosti, who used roentgen therapy, have found encouragement in their results. According to Polkey, in the 419 cases that have been reported in the literature, 76 cures were obtained by different methods of treatment. Among the various modes of treatment, roentgen rays and surgical excision appear to have achieved a majority of the few cures reported.

For several years we have treated keloids with radium, by using heavy filtration (that is, 1.5 mm. of monel metal and 2 mm. of lead). This filtration absorbs the beta particles and 14 per cent of the softer gamma rays. The results in the treatment of keloids have been encouraging. Noting the similarity of fibrous plaques to keloids, we determined to use heavily filtered radium for the former condition.

During 1935, 1936 and 1937 a sufficient number of patients with fibrous plaques were treated with radium to permit us to make a special file and obtain material for study. The object of this study is to sum-

* Read at the Thirty-ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 20-23, 1938.

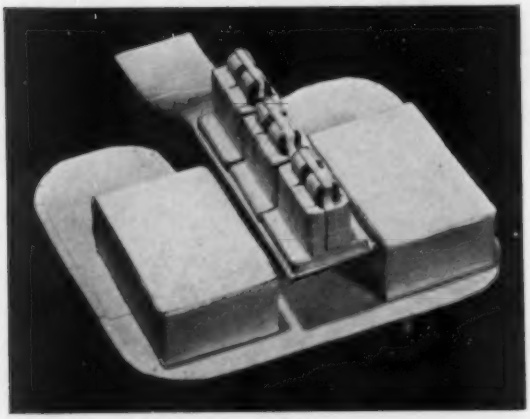

Fig. 1. Apparatus with tubes in place (top view).

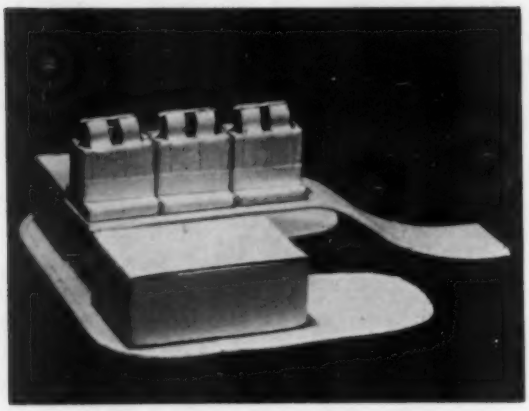

Fig. 2. Apparatus with tubes in place (lateral view).

marize the findings and results and to evaluate the use of radium according to our technique in this rare but troublesome disorder.

Thirty-four patients were treated in the three years. The age distribution was interesting. The youngest patient was thirty-two years of age and the oldest was sixty-nine years of age; the average age of the patients was fifty-four years. Of the 34 patients 19 were in the sixth decade and 9 in the seventh decade of life.

Hoping to throw some light on the etiology of the disease we made an investigation of the incidence of specific infection and antecedent trauma in the 34 cases. The result was not very helpful. Syphilis was probably present in 4 cases (about 12 per cent); the results of flocculation tests were strongly positive in 1 case but questionable in 3 cases. A history of gonorrhea was obtained in 7 cases (about 20 per cent); in these cases the gonorrhea, which had occurred thirteen to forty years previously, was inactive at the time of this investigation. In 2 cases there was a history of both gonorrhea and syphilis. In 7 cases (about 20 per cent of the series) trauma had been produced by instrumentation. In 3 cases the trauma had resulted from the passage of sounds, in 2 cases it had occurred during cystoscopy; in 1 case it had occurred in the course of removal of urethral polyps with electrosurgery, and in 1 case it had occurred during transurethral prostatic resection. In 3 of the 7 cases there also was a history of gonorrhea or syphilis. In 13 cases there was a history of gonorrhea, syphilis or instrumentation.

CHIEF COMPLAINTS

The chief complaints, which were listed in the order of their frequency, were as follows: deformity and pain on erection in 16 cases; deformity on erection in 14 cases; painful coitus in 8 cases; palpable nodules in 8 cases; unsatisfactory sexual intercourse in 2 cases and urinary disturbance in 1 case.

Painful or difficult coitus and deformity (usually dorsal curvature) with pain on erection were the associated symptoms that occurred most frequently.

The duration of symptoms is important. This information was obtainable in 32 cases. The shortest duration noted was two months, the longest was fifteen years, and the average was 20.5 months. This information becomes pertinent when the results of treatment are analyzed. Cartilage and bone are often deposited in cases in which the disease has been present for a long time. These tissues are not greatly influenced by irradiation.

Fibrous plaques were definitely palpable in 26 of the 34 cases. In the remaining 8 cases only a diffuse thickening was found.

Thirty of the 34 patients had not received any treatment for the disease. Two had received roentgen therapy and 1 had

received radium therapy; in 1 case the plaques had been removed surgically.

TECHNIQUE

As mentioned previously, very heavily filtered radium was employed. The scrotum was protected with a heavy lead plate. This plate bridged the thighs and formed a support for the apparatus. We have used two or three radium tubes, each of which contained 50 mg. of radium sulfate (element); the radium was filtered with 1.5 mm. of monel metal and 2 mm. of lead. The tubes were mounted at a distance of 1 inch (2.5 cm.) from the skin of the penis; this distance was maintained by mounting the tubes on blocks of balsa wood that were 2.5 cm. thick and 4 cm. square at the base; one tube was mounted on a block. The two or three blocks were swung or suspended as a short apron from the suprapubic region and usually were mounted on cardboard. Empty wooden blocks were attached to the sides of the loaded ones and these rested on the lead plate forming the sides of the arch (Figs. 1 and 2). The penis was kept between the lead plate and the arch of wooden blocks. If micturition became necessary during the treatment, the apron of loaded blocks could be lifted up. The choice between two or three blocks depended upon the extent of the fibrous plaque. Thus, in our series of cases two blocks sufficed in 21 cases and three blocks were used in the remaining 13 cases. The duration of treatment was overnight (twelve hours). Therefore, the dose was about six-sevenths of an erythema dose, considering the distance and filtration. One treatment only was given in many cases. We requested reports of progress from the patient and felt that if one treatment produced relief a second treatment should be given in three or four months. After a lapse of an additional three or four months a third treatment was applied in a few instances. In our series of cases, 20 patients received one treatment only, 11 received two treatments, and 3 received three treatments.

RESULTS

We were able to obtain follow-up data in 31 of the 34 cases. In 2 cases in which the patients had died suddenly of cardiac disease we were unable to obtain any information about the progress of the fibrous plaque after the patients left the clinic; in 1 case the patient could not be traced.

Eighteen patients received only one treatment; therefore the results could be determined only by detailed letters from the patient or his home physician. In the remaining 13 cases 10 patients returned for a second treatment and 3 returned for a third treatment. In these cases the results could be accurately ascertained by examination of the affected part.

Results were judged very critically and impartially to obtain a reliable evaluation of this mode of treatment. The results were

Table I

RESULTS OF RADIUM THERAPY IN CASES OF PEYRONIE'S DISEASE

Number of Treatments	Cases	Results					
		Good		Fair		Unimproved	
		Number	Per Cent	Number	Per Cent	Number	Per Cent
1	18	2	11.1	4	22.2	12	66.6
2	10	3	30.0	4	40.0	3	30.0
3	3	1	33.3	2	66.6		
Total	31	6	19.3	10	32.2	15	48.3

graded "good," "fair" and "unimproved." The good results may be considered as cures. Disappearance of the plaque (although diffuse scar tissue always remained) and practically complete disappearance of the deformity on erection were the criteria. For "fair" results, marked amelioration of symptoms and definite reduction of the plaque were deemed necessary. In many cases in which the result was classified as "unimproved" the deformity had become less and there had been some subsidence of the fibrous plaque, but the result was not striking or definite. The results are shown in Table 1.

Correlation of these results with the duration of symptoms before treatment and with the number of treatments given proved informative. As mentioned previously, the average duration of symptoms in all the cases was 20.5 months. The average duration of the disease was as follows: six months in the group of cases in which the results were classified as "good," twenty-one months in the group of cases in which the results were classified as "fair," and twenty-nine months in the group of cases in which the results were classified as "unimproved."

This was expected and quite logical. If one remembers that cartilage and bone are radioresistant tissues and are often deposited in fibrous plaques that have been present for a long time, one would expect poor results in cases in which the disease had persisted a long time before treatment was started.

The relation between the number of treatments employed and the results obtained is shown in Table 1.

SUMMARY

Fibrous plaques of the penis fortunately are rare; while they do not constitute a serious disease as far as life itself is concerned, they interfere with sexual function and often lead to neurasthenia and allied mental dyscrasias. A variety of methods of treatment have been employed in the past. Polkey's excellent summary of the reports of 419 cases showed that a cure was obtained in only 18 per cent of cases and that in an additional 9 per cent of cases improvement was obtained by all methods of treatment. Roentgen therapy or radium therapy was employed in only 14 of the 76 cases in which a cure was obtained. The idea of treating this condition with very heavily filtered radium, that is, with a technique similar to that employed in the treatment of keloids was not our original idea. The method was mentioned by Sonntag (1921), in quoting the work of Dreyer who reported the successful use of radium in 1 case in 1911. He employed the Wickham and Degrais heavily filtered method as used for keloids. In the 31 cases in which the patients could be traced we have achieved the same rate of cures with radium alone that Polkey reported with all methods; in addition, 32 per cent of our patients were definitely improved, while in the cases reviewed by Polkey only 9 per cent of patients were improved. This study tends to show that our main fault has been undertreatment. In four-fifths of the cases in which the results were classified as "unimproved" the patients received only one application of radium therapy. One excellent feature of this method of treatment is the freedom from harmful after-effects. By keeping under an erythema dose we have avoided injury of the skin and edema of the tissues. The method is time-saving; it requires only an overnight treatment, followed by another overnight application three or four months later. This study also has indicated that especially in the earlier stages of the condition the prognosis is good and treatment is worth attempting. In the later stages, that is when the condition has been present for more than two years, treatment should not be urged but may be attempted as a therapeutic test.

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DISCUSSION

Dr. C. A. Waters, Baltimore, Md. Never have I been asked to discuss a paper about which I know less than the one just presented by Dr. Fricke. I suppose the reason for asking me to open the discussion is that in 1915 Dr. J. A. C. Colston and myself reported the unsuccessful results of the roentgen treatment of 3 cases of fibrosclerosis of the penis.

Dr. Fricke's excellent survey of this work would seem to tend to show three things: (1) the shorter the duration of the disease, the greater the chance of improvement—which seems reasonable; (2) that in the favorable cases radium yields more satisfactory results than surgery; (3) that apparently small amounts of radiation in favorable cases give results.

For the sake of the record, I should like to state the approximate amount of radiation we gave our 3 cases which failed to show any improvement. While this was a long time ago and it is impossible to translate technical factors used then with modern procedures, nevertheless one can see from the following description that a lot of radiation was given; I believe we gave far more than has been given in Dr. Fricke's cases. The first case was given almost daily doses over a period of about two months. The daily doses averaged approximately 2½ H, using 2 mm. aluminum filter. The second case was given daily doses of 3½ H over a period of one month which was further subjected to another two weeks' treatment after the reaction subsided. The third case received only one month of daily treatments.

In our 3 cases considerable infiltration and swelling developed, and we thought for a time that distinct improvement was resulting. However, later we found that the edema and swelling obscured the fibrous plaques and finally, when all the reaction was over, there was no change in these indurated areas. Of course, as I just stated, it is impossible to compare the amount of radiation with the old method of measurement with Dr. Fricke's measurements, but it does seem to me that we gave our cases a great deal more than he has given his. However, I think he has clearly shown that if these cases could be seen a little earlier irradiation is the choice of treatment of this troublesome condition.

Dr. George E. Pfahler, Philadelphia, I want to congratulate Dr. Fricke on the excellent results that he has obtained. I, too, have treated some of these cases by irradiation and I did get improvement with disappearance of the palpable induration, but I also got telangiectasis.

I am rising to speak not to add my experience to that of Dr. Fricke's. I want to call attention particularly to the absence of disagreeable results by the form of treatment which he has used, and to emphasize what Dr. Merritt and I have been particularly emphasizing for several years. I am sure there is a difference in the biological effect of gamma rays filtered through the equivalent of 4 mm. of lead as compared with low voltage roentgen rays. It is not merely the matter of delivering a certain percentage of rays into the affected tissue, for we all must realize that even soft rays can be carried to a very high percentage into this lesion. When one is using 2 mm. of copper or the equivalent of 4 mm. of lead, even about 14 per cent of the gamma rays are filtered out and only the harder gamma rays reach the tissues which are to be affected.

My patients were all treated with 130 kv. technique, using 6 mm. of aluminum filter. I use these soft rays because I reason that this

lesion is very superficial and one should get the effect with relatively soft rays. In treating this lesion which is a soft tissue, very superficial, there exists an excellent example of the different effects that one obtains by using the highly filtered gamma rays as compared with the so-called soft radiation.

Dr. Fricke (closing). I want to thank Dr. Waters and Dr. Pfahler for their discussion and for bringing up the principle of filtration. We have used either two or three tubes, dependent on the length of the fibrous plaque, of 50 mg. each of radium sulfate, which was filtered with 1.5 mm. of monel metal and 2 mm. of lead, cutting down the gamma rays by 14 per cent.

Sometimes we do too much for these patients. I was interested in reading the German article written by Dreyer in 1911 in which he reported a case. This patient, aged thirty-seven, had been unable to have sexual intercourse for nine months and had much curvature of the penis. Dreyer gave several treatments without result. Then he adopted the Wickham and Degrais apparatus with 2 mm. of lead filtration and cured the condition. He said, however, that unfortunately the man came back for treatment of lues shortly thereafter.

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ROENTGEN THERAPY OF CYSTIC HYGROMA OF THE NECK IN CHILDREN*

By FRED M. HODGES, M.D., L. O. SNEAD, M.D., *and* R. A. BERGER, M.D.

RICHMOND, VIRGINIA

THE treatment of cystic hygromas of the neck, regardless of their exact extent and location, or the age of the patient, has in the past been almost entirely surgical. Where the growth could be completely removed this has given results which were entirely satisfactory. In some cases, where it was thought that the growth had been entirely removed there have been recurrences. In a large percentage of cases seen, complete surgical removal is impossible. This is particularly true in infants and small children, where the tumors may be very large and frequently extend down into the mediastinum, the axilla or the pleura.

Thompson and Keiller, Dowd, MacGuire and others believe that hygroma of the neck develops from lymphatic rests or remnants of the primitive jugular sacs, and that lymph vessels are formed without sufficient communication with the larger vessels in the particular area involved. Later this gives rise to large cystic lymph tumors.

These growths usually involve the side of the neck but may extend upward over the side of the face, downward to the supraclavicular fossa, and into the mediastinum, axilla and pleura. They are usually multilocular but may be unilocular; they may be made up of small or large cysts which are lined with endothelium and contain serous fluid. In some the walls of the cysts are very thin and in others they are thick and contain a great deal of vascular and lymphatic tissue. In some there are nodules throughout the growth; these are made up largely of vascular and lymphatic structures. In infants and young children this type seems to predominate; in older children and adults the thin wall type apparently predominates. Clinically these congenital growths are usually noticed at birth or shortly afterwards. Occasionally these tumors are very large at birth even interfering with delivery. Usually, however, they are small and may not be noticed until some time after birth. They are usually soft, freely moveable and not compressible. The overlying skin is free and in the majority normal in appearance, though it may be wrinkled or thickened. Some grow slowly; others rapidly. They are painless but may give pressure symptoms such as dyspnea, dysphagia, etc.

Vaughn, Dowd, and MacGuire, in separate studies of the literature up to 1935, found 163 recorded cases with only 19 in adults. In 1938 Fleming added 2 fully developed cases in adults. Vaughn reports one very extensive growth on the side of the neck removed by surgery and with an excellent result.

In Dowd's review which covered the literature to 1913 he found 137 cases. He also reported 4 cases of his own. In this series, the neck was the site of involvement in 91 instances, the axilla in 35, with the others occurring in different parts of the body.

Goetsch recently reported 12 cases of hygroma colli cysticum and gives a very thorough and comprehensive study of the etiology, pathology and characteristics of these growths. He states: "Irradiation has been practiced in the past with indifferent results. For very large tumors in children under 6 or 8 months of age, irradiation preliminary to surgical treatment is desirable. Secondary surgical excision, however, is still necessary for cure." Goetsch reports one fatality, 11 good results. Five of these could not be followed after a few months. One was being treated by roentgen irradiation. This case had mediastinal involvement and the growth could not be completely removed by surgery. He reports

* Read at the Thirty-ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 20–23, 1938.

Fig. 1. Case 1. *A*, January 9, 1924. Shows a large mass on the left side of the face and neck; *B*, June 11, 1924. Mass has practically disappeared, six months after beginning of treatment; *C*, March 13, 1926. No evidence of the mass in the face or neck; *D*, September 12, 1938. Same child fourteen years later showing a normal individual.

that roentgen therapy caused a marked shrinkage of the tumor. In the published films, however, all evidence of the growth seems to have entirely disappeared.

Figi in 1929 reported 13 cases, 12 of which were treated with radium. Only two of these children were more than three years of age; "the oldest was thirteen years, the youngest four and a half weeks. Four of the patients were boys and 9 were girls. The tumor was situated on the right side of the neck in 5 cases, on the left in 5, and involved both sides in 3." Three were cured, one much improved, and 7 died of infection. His conclusions were: "From experience with treatment by radium in 12 cases of multilocular lymph cysts in children, radium appears to be of definite value. The tumor may be reduced to such size as to permit surgical removal or it may disappear entirely." Seven patients in Figi's series died from acute infection from the tumor but 4 of these were already infected when first seen. In some cases radium was applied during the period of infection without any aggravation of the infection or without any beneficial results except in one case where the tumor rapidly disappeared. This series of 12 cases was evidently an extremely difficult group with which to deal by any method of therapy. None were considered suitable for surgery and 4 were already infected. His final results were far above the average in such a group. He complains of the length of time required for radium treatment, these treatments being given as a rule two months or more apart. The results with roentgen therapy have been more rapid. The treatments have been given once a month and the entire involved area treated.

Figi believes that the rarity of the condition in adults is due to the fact that the large majority die of infection during infancy or childhood. A small percentage of cases of hygroma colli apparently develop in adults. The second case reported by Fleming was of this type.

Some writers believe that fairly frequently there is spontaneous regression of the tumor following acute infection. Most authorities, however, have never seen a case regress from infection alone.

In 7 cases we have obtained 4 excellent results, 1 fair result and 2 failures. One failure was in a boy nine years of age, another in a girl eleven years old. In these 2 latter cases the growths had been noticed since birth.

Case 1. I. L., female, aged six months. The large growth on the left side of the neck was noticed as a very small nodule about two weeks after birth. It grew very rapidly and after six months it was a large lesion involving the side of the neck and extending well up over the face on this side. From January 9, 1924 to May 23, 1924 she received six treatments at approximately three week intervals. The total dose

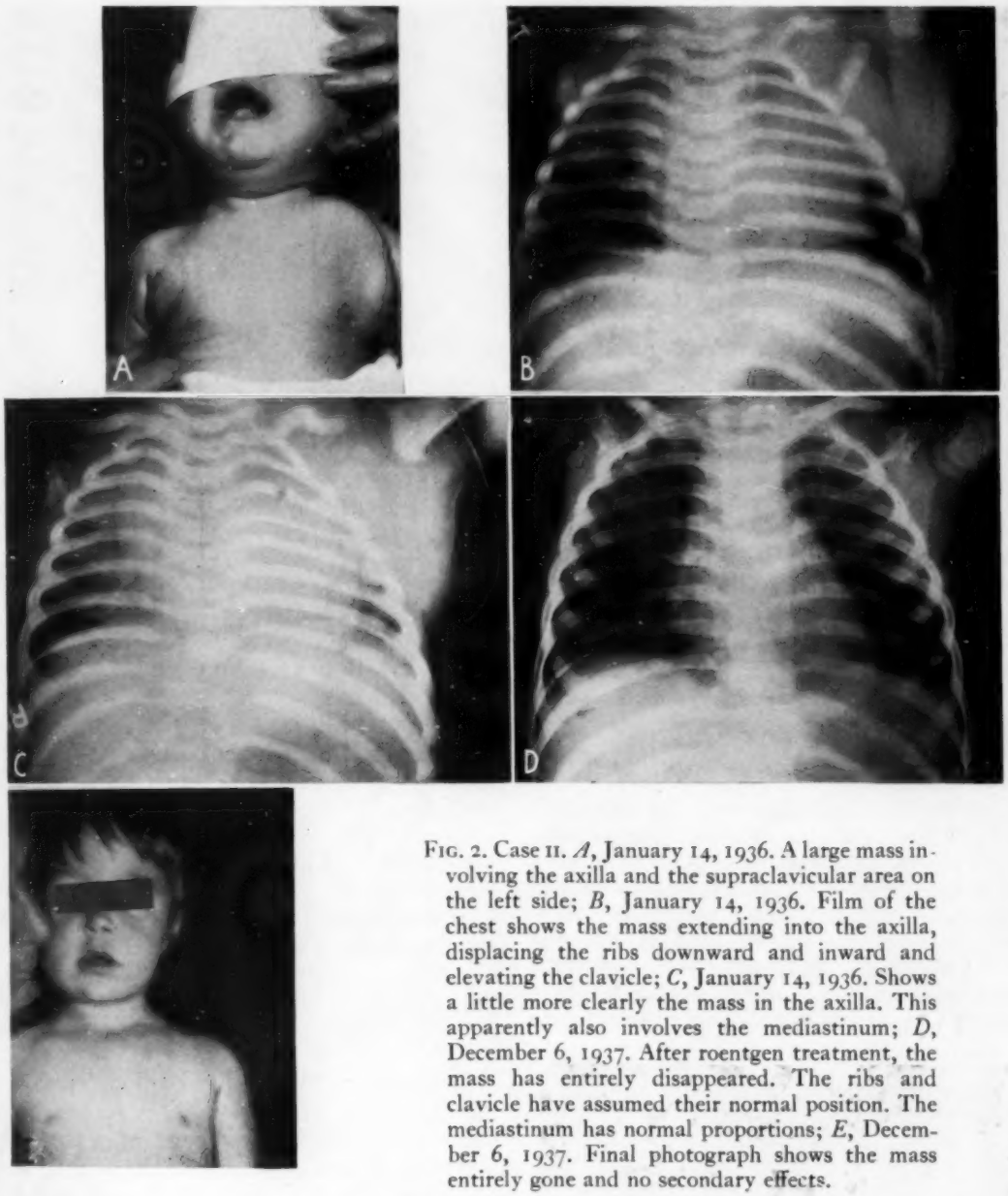

Fig. 2. Case II. *A*, January 14, 1936. A large mass involving the axilla and the supraclavicular area on the left side; *B*, January 14, 1936. Film of the chest shows the mass extending into the axilla, displacing the ribs downward and inward and elevating the clavicle; *C*, January 14, 1936. Shows a little more clearly the mass in the axilla. This apparently also involves the mediastinum; *D*, December 6, 1937. After roentgen treatment, the mass has entirely disappeared. The ribs and clavicle have assumed their normal position. The mediastinum has normal proportions; *E*, December 6, 1937. Final photograph shows the mass entirely gone and no secondary effects.

was approximately 600 r. Observation fourteen years later, September 8, 1938, reveals a normal, healthy girl with no asymmetry of face, normal teeth, and active salivary glands.

Case II. J. T., female, aged eleven weeks. A large cystic type of growth about the size of an orange was palpable in the left base of the neck and extended down into the left pectoral area and axilla. This mass was not noted at birth but was first seen at about six weeks of age and grew rapidly from this time. The parents first thought that the clavicle was dislocated. Films made at eleven weeks show a definite pressure deformity displacing the upper ribs and a large growth in the neck and axilla. Roentgen therapy was started on January 14, 1936, and was continued through August, 1936. During this period the patient received 700 r with 135 kv., 3 mm. Al. This treatment caused a complete regression of the growth in the chest, axilla and neck.

Case III. C. H., male, aged two. At birth one side of the lip was markedly enlarged. This continued to grow slowly until April 5, 1936,

Fig. 3. Case III. *A*, April 13, 1936. A large infected lymphangioma of the upper lip which entirely obscures the mouth and lower lip; *B*, October 24, 1936. The infection has subsided and the lesion has markedly regressed; *C*, August 18, 1938. This case is still under treatment. The upper lip has reached almost normal proportions.

when the lip became infected. When first seen on April 19, 1936, the large growth on the upper lip was infected. The biopsy report was an infected lymphangioma. Roentgen therapy was given from April, 1936, to March, 1937, at one to two month intervals, using 50–150 r at each treatment. The total dose was approximately 900 r. This, of course, is not a true hygroma but is very similar and is included in order to show that infection of these growths is no contraindication to irradiation.

Case IV. D. J., male, aged three. At birth a marked enlargement of the side of the face was noticed. The parents have not noted any change in the appearance since birth. Five treatments have been given since May, 1938. The growth is smaller, but is rather radioresistant and surgical removal will, we believe, be necessary. He has been under treatment only four months, however, and further regression of the mass is probable.

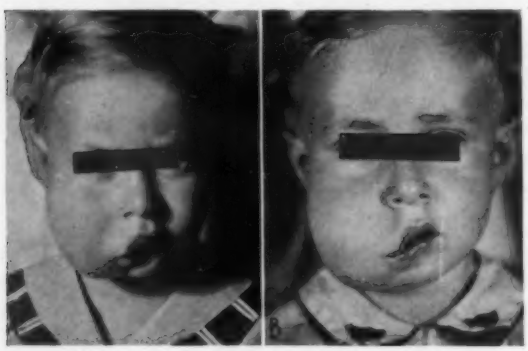

Fig. 4. Case IV. *A*, May 20, 1938. A large mass involving the right cheek and submaxillary area with distortion of the mouth and lower eyelid; *B*, September 13, 1938. Less swelling of the cheek beneath the eye and less distortion of the mouth.

Case V. L. G., male, aged one. Had a fairly large hygroma on the right side of the neck. This was noticed shortly after birth and was growing slowly when first seen in August, 1929. The tumor regressed rapidly under roentgen therapy but we have been unable to trace this case for a final result.

Cases VI and VII, one in a boy nine years old, the other in a girl eleven years of age, were failures. The boy had involvement of the right side of the face and the floor of the mouth. This had been present since birth. Surgery was not considered advisable. Roentgen therapy caused very little change in the growth. We do not know the ultimate result in this case. The girl had a well limited cystic growth about the size of an orange on the left side of the neck. This was not radiosensitive and was removed surgically.

The following factors were used in treatment: 125 to 130 kv., 6 mm. Al filter, 10 to 12 inch distance and once a month a dose of about 100 to 150 r, measured in air, was administered to the entire growth.

CONCLUSIONS

1. Cystic hygroma of the neck in infants and small children is frequently a radiosensitive growth.

2. In many of these cases the tumor extends down into the mediastinum, the axilla or pleura, and complete surgical excision is impossible.

3. Roentgen therapy will cause a complete regression of the growth in a fairly large percentage of the cases. In others, the tumor may be shrunk to a point where surgery is possible.

4. We believe this treatment, on account of the better cosmetic results which can be obtained and its lack of danger, should be tried before resorting to other methods in all cases except the very thin-walled, well-circumscribed, cystic types which can be easily excised.

5. These growths should be treated when first noticed since here, as in angioma and keloid, the early stage of development seems to be much more radiosensitive. Also many grow more or less rapidly and later a much larger area may have to be irradiated.

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DISCUSSION

Dr. Eugene T. Leddy, Rochester, Minn. There is not a great deal I can add to the excellent presentation by Dr. Hodges on hygroma cysticum colli in children. As a matter of fact, I have no business in discussing this paper at all, not only because I have nothing to add but also because my own experience in treatment in this regard is limited to two cases.

Just before I left Rochester, I asked Dr. Figi what his present views were on the treatment of this condition and he favored irradiation except in very rare instances.

Dr. Fricke, who has had far greater experience in the treatment of this condition than I have had, has kindly consented to discuss the cases in which radium therapy has been given, as most of the patients treated at The Clinic have had radium therapy rather than roentgen therapy.

However, I think that the points Dr. Hodges made are very important, namely, that these hygromas should be diagnosed early and that radiotherapy should be given early because of the fact that subsequent to operation most of these lesions become infected.

I mentioned my experience with two children who had cervical and mediastinal involvement and as was the case with Dr. Hodges' patient, their lesions also responded well to treatment.

On general principles, one would predict that the tumors made up of radiosensitive cells, such as lymphangiomas, should respond favorably to radiotherapy. As a rule they do. Therefore, I can see little reason for suggesting that these patients should be operated on, because radiotherapy does not entail any risk such as that of infection and generally produces a good result.

Dr. Robert E. Fricke, Rochester, Minn. Our experience at the Mayo Clinic has agreed with Dr. Hodges' excellent paper. I have a few slides which I would like to present. This first slide shows two things: The extreme rarity of this condition, and secondly, the distribution of methods of treatment. Prior to 1918, all cases seen at the Mayo Clinic were operated on. However, in view of the youth of these patients and the extensiveness of the condition, often into the mediastinum, since 1918 all cases have been treated either with radium or roentgen rays, and radium has predominated with us because of the fact that the radium blocks could be easily attached and would remain in position. The next two or three slides are some of the cases that Dr. Figi referred to us for treatment, and show the appearance before and after treatment. The treatments are tedious, and usually about four are necessary, three or four months apart, and during this interval of time an acute infection may develop and may result fatally, so about half of these cases were lost. However, these which we are showing cleared up completely with radium therapy, with suberythema doses to the neck.

LOW VOLTAGE LIGHTLY FILTERED ROENTGEN RADIATION VERSUS RADIUM AND HIGH VOLTAGE ROENTGEN RADIATION IN THE TREATMENT OF SUPERFICIAL CANCER*

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SUPERFICIAL cancer has always been a subject of much interest to radiologist, dermatologist, and surgeon.

The subject has been interesting to me because it has been a noticeable experience that superficial cancer appears unusually common in certain Rocky Mountain states. The high, dry, arid desert localities, with intense sunlight and in places almost constant wind in summer and winter, and exposure to cold, are probably responsible for this high incidence.

It is of interest to observe that sun, wind and cold also act as causative factors in producing late necrosis in previously irradiated tissue.

The common occurrence of cancer on the face, ears and neck, and the attending complications and disfigurements make it highly important from treatment standpoint and cosmetic results.

Surgery, radium and roentgen rays have proved to be the effectual methods of controlling the disease, either alone or in combinations.

The literature is full of good results from a wide variety of methods used.

The purpose of this paper is not to introduce anything new, but to present methods used in treatment, and to consider factors that have seemed important in success and failure in the treatment of the disease.

For a number of years, I have been using radium and surgery; and for a shorter period, surgery, radium and roentgen rays, in the treatment of superficial cancer. All three agents have proved successful in controlling the disease under certain circumstances of location, size, and tumor type. As a complete procedure, surgery has been used less frequently than other methods, it being reserved largely as a complement to irradiation. Low voltage lightly filtered roentgen radiation; high voltage roentgen radiation; and lightly and heavily filtered radium have been used either alone or in combination, to suit special needs.

The following factors have been used:

1. Low voltage, 140 kv., filtration equivalent to 0.25 mm. of copper, 50 cm. target-skin distance; effective wave length 0.227 Å.
2. High voltage, 200 kv., 0.5 mm. of copper, 50 cm. target-skin distance; effective wave length 0.149 Å.
3. High voltage, 200 kv., Thoraeus filter, equivalent to 2 mm. of copper, 50 cm. target-skin distance; effective wave length 0.117 Å.

All measurements have been made in air, and with 25 ma. current.

4. Radium has been used as surface applicators, with 0.5 mm. of silver at 2 mm. distance;
   Radium plaques at 1 cm. distance, with filter equivalent to 2 mm. of brass;
   Radon seeds.

A target skin distance of 50 cm. was used for convenience of equipment available.

For small fields it would closely compare with 25 to 35 cm. distance, as the difference in depth dose would not be great. In larger fields it is unnecessary and probably a disadvantage in most cases, from the standpoint of increased depth dose with unnecessary irradiation of normal structures, and might add to the possibility of both delayed healing and late radiation fibrosis and necrosis.

At the present time, 35 cm. distance is being used.

* Read at the Twenty-third Annual Meeting, American Radium Society, San Francisco, Calif., June 13–14, 1938.

Except for small superficial lesions where single intensity of doses has been used, most treatments have been by divided doses.

CLASSIFICATION OF SUPERFICIAL CANCER

The lesions have been classified on the basis of those of lesser, and those of marked infiltration, and those of recurrent and resistant disease. Only clinical judgment could be used as a guide in determining the amount of infiltration, and undoubtedly the evaluation is rather empirical.

Biopsies have been taken wherever possible, but have not always altered clinical impressions of advisability of procedures to be used.

In general, proved basal cell lesions have responded to far lesser intensities than strict squamous cell lesions. Mixed basal and squamous cell varieties, and the difficulty of differentiating these types at times especially where there are slough, infection, and fibrosis resulting from previous treatment, lead one to believe that it is probably safer in general to treat most superficial cancers with maximal intensities where cure is possible. It may be true, under these conditions, that a higher percentage of fibrosis and necrosis will occur, but also a higher percentage of clinical cures will result.

SELECTION OF METHODS OF TREATMENT

The treatment of superficial cancer is a definite individual problem. Surgery, radium, and roentgen radiation may be used, alone or in various combinations. Most of us will probably agree that no one agent is suitable to all clinical or histological types of the disease and under all conditions; or that one agent might not have to be changed for another to suit special needs while treatment is in progress.

The ideal method of treatment would be the one which is the most simplified that will control the disease adequately with the least amount of normal tissue damage and prevent the possibilities of future recurrences; and, in case of irradiation, the late complicating effects of attending fibrosis, infection, and necrosis.

Unquestionably, clinical judgment cannot be set forth in terms of any particular formula for treatment. What might be considered the best form of treatment in one physician's hands, may not be the best in another's, because clinical experience, judgment and adaptation of various forms of equipment and agents at one's command may be different; nevertheless the results may be about the same.

We probably can all recount experiences with uniformly excellent results, of cases treated by surgery, radium or roentgen radiation alone, in small superficial cancers. It makes little difference which method is used if adequate treatment is given, aside from the resulting cosmetic effects which are important to consider, especially in cancer about the face.

In general, in cancer about the face irradiation is usually the method of choice, but surgery cannot be dispensed with. Surgery undoubtedly has many merits either alone or as a complement to irradiation. This is especially true in certain bulky lesions.

SUPERFICIAL LESIONS OF SLIGHT OR MODERATE INFILTRATION

It is well known that these types of lesions have been successfully controlled in a high percentage of cases, with low voltage unfiltered roentgen rays, and lightly filtered radium, either in single doses of varying intensities, or by fractional or divided doses. Theoretically and practically, this should be the ideal procedure to be used. Depth dose is no special consideration. Absorption in superficial tissues of long wave length radiation is known to be high. It is important to preserve normal tissues from unnecessary effects of greater depth dose radiation produced by higher voltages and heavier filters wherever possible. Tissue tolerance is especially high to low voltage unfiltered irradiation, particularly in smaller surfaces irradiated. Tissue recovery and subsequent healing is very noticeable. Low

voltage lightly filtered roentgen radiation seems equally efficient, and practically, in addition, should be somewhat more efficient because of the slightly increased depth dose. However, the slight difference in quality of radiation is probably not a very important consideration here. The quantity of radiation used is important. Poor results and recurrent disease can often be explained by insufficient total dosages used, rather than any particular quality of radiation used.

Superficial lesions of slight or moderate infiltration up to 2.5 cm. in diameter, and even larger, have been controlled by divided doses of low voltage lightly filtered roentgen radiation over a period of one to four weeks time, of 1,000 r weekly. The lesions usually heal with a minimal amount of scarring and with little or no atrophy of normal structures in a high percentage of cases. In these superficial lesions, 1,000 r has been inadequate and not to be depended upon. The average dose has been about 2,000 to 3,000 r. Larger lesions have responded well to weekly doses of 750 to 1,000 r, for a total dose of about 2,000 to 3,000 r.

It appears that this group can be controlled just as effectively with low voltage lightly filtered roentgen radiation as by the use of lightly filtered radium, or the higher voltages of roentgen rays. There is no doubt that radium of light filtration and of single intensity of dosage, or the higher voltages of roentgen rays are efficient in controlling smaller lesions in a very high percentage of cases, but cases treated by these methods produce no better results and appear to be followed by more fibrosis, and more atrophy of normal tissues than those treated by low voltage lightly filtered roentgen rays.

In cancer involving cartilage of the ear and nose, low voltage lightly filtered roentgen radiation seems superior to lightly filtered radium, both from the ease of application and from the noticeably less difference in late complicating effects.

SUPERFICIAL CANCER OF MARKED INFILTRATION

Superficial cancer of marked infiltration and especially the larger lesions and those cases of known long duration and resistance offer special problems that are not so simple from the standpoint of cure and late complicating radiation effects.

The solution in marked infiltrating lesions may best be met in most instances by a consideration of quality of radiation as well as quantity, expressed in higher voltages of roentgen rays and heavier filtrations and increased protraction of dosages; or the use of heavily filtered radium in the form of plaques at a distance. Greater penetration and depth dose in this type of radiation seems a practical consideration in this group. Low voltage lightly filtered roentgen radiation has been used in a number of smaller lesions of this group. The following technique has been used:

1. Low voltage lightly filtered roentgen radiation, 140 kv., equivalent to 0.25 mm. of copper, at 50 cm. target-skin distance, effective wave length 0.227 Å; 450 r represents a threshold erythema dose; 500 r daily for a total of 4,000 to 5,000 r.

The variations in dosages quoted in this paper depend upon the relative size, thickness and resistance of the lesions.

While many lesions in this group have been successfully controlled with low voltage lightly filtered roentgen radiation, sufficiently often recurrences have followed or residual disease has required complementing the treatment with gold seeds or changing to heavier filtered radium or to the higher voltages of roentgen rays for complete control of the disease.

Single doses of lightly filtered radium or single or divided doses of low voltage lightly filtered roentgen radiation sufficient to control other than the smaller lesions, has resulted in delayed healing and at times slough that has necessitated some form of surgical care as a final measure to relieve pain and insure healing.

In general, except for selected smaller lesions, it seems more advisable to favor higher voltages of roentgen rays with heavier filtration and divided dose method. The usual technique followed here has been:

1. High voltage, 200 kv., 0.5 mm. of copper, 50 cm. target-skin distance, effective wave length of 0.149 Å. Threshold erythema dose 550 r.
   Lesions under approximately 2.5 cm. in diameter, 500 r daily, for a total of 2,500 to 5,000 r.
   Lesions over 2.5 cm. in diameter, 300 r daily for a total of about 3,000 r.
2. Radium plaques filtered equivalent to 2 mm. of brass, at a distance of 1 cm. with single doses of 500 to 1,200 mg-hr. have been used.

In many instances in smaller lesions raised above the surface of the skin, it has been an advantage to first remove the redundant lesion with a cautery loop. The material obtained has served for biopsy, and the procedure has made possible reduced dosages necessary for control of the disease and avoided at times the necessity of complementing residual disease with gold seeds or reverting to some other procedure for control of the disease. This procedure of removal of tissue is not to be recommended where cosmetic results are highly important.

Heavily filtered radium at a distance in single doses undoubtedly is dependable in caring for many of the smaller lesions in a selected group of cases. This form of therapy has seemed indispensable in many of the smaller deeply infiltrating lesions especially of long duration. However the scar seems less pliable, with more fibrosis, distinctly more atrophy, and apparently increased tendency to radiation necrosis. These are not always major considerations, however, when disease threatens to be especially resistant and difficult to control.

Implantation of radium seeds has been effective in controlling the base of many of these lesions, in cases where a full tolerance of skin dosage of higher or lower voltages of roentgen rays has been used, or where heavy filtered radium at a distance has failed to cause complete regression. Because of the difficulty of approach to certain infiltrating lesions about the inner canthus of the eye and auditory canal and selected lesions elsewhere, implantation of gold seeds has proved adequate for control and has been the most simplified treatment procedure. Smaller divided doses of high voltage roentgen radiation over longer protracted periods, especially in the larger lesions, has seemed a distinct advantage because of better control of dosage and protection of normal structures. The intervals between doses gives a better opportunity to observe irradiation and regressive tumor effects and a better appraisal of the necessity for maximum or minimum dosages. Ewing and others have frequently emphasized the importance of the most careful adjustment between dosages necessary to cause degeneration of cancer cells and at the same time protect skin and underlying fibrous and vascular structures from permanent damage. This must be kept in mind if one is to obtain the best curative and cosmetic results, especially in the larger lesions.

RECURRENT AND RESISTANT LESIONS

For recurrent and very resistant lesions that have failed to respond to other methods, higher voltages and heavier filtration over a protracted period have been used effectively with the following technique:

1. 200 kv., Thoraeus filter equivalent to 2 mm. copper, 50 cm. target-skin distance, effective wave length 0.117 Å, 250 to 350 r daily for a total of 4,000 to 6,000 r; the larger doses being given in smaller lesions and the smaller doses in larger lesions.

The increased quality of this type of irradiation has seemed distinctly more advantageous. The skin effects have been noticeably less severe and the tissue tolerance has appeared greater than where similar or lower voltages of lighter filtration have been used. Clinically, it gives one the im-

pression that there is a different biological effect produced by this quality of shorter wave length radiation.

Some of the larger lesions and especially those of marked resistance, have been treated by smaller divided doses over a longer protracted period. Treatment period in these cases has extended over two to two and a half months, and dosages as high as 7,000 to 8,000 r, have been used. Healing has taken place, with surprisingly little fibrosis in some cases, but in others I have wondered whether bone and underlying soft tissues have not been unnecessarily damaged.

In lesions uncontrolled by irradiation, with resulting marked fibrosis, necrosis, and infection, surgery is indispensable in relieving pain and clearing away permanently damaged tissue of radiation effects. Under such extreme fibrosis, further irradiation appears quite useless and not to be recommended.

The entire problem, in the last analysis, seems to amount to a careful appraisal of the case as an individual entity, on its own merits, and treatment planned accordingly.

CONCLUSIONS

The choice of treatment depends on personal clinical experience, availability of various radioactive sources, location, size, infiltration, age, and histological characteristics of the lesion, and the cumulative evidence of late effects or end-results from various methods used.

The best cosmetic effect with minimal normal tissue damage and adequate destruction of the disease, with greatest protection against recurrences, are of primary importance.

The consideration of the operator from the standpoint of hazards from methods and sources of radiation should be considered. It is not so much seeking something new, but rather that of applying to better advantage the fundamental principles already known, that makes for failure or success in most instances.

Low voltage lightly filtered roentgen radiation is quite as efficient as radium, and offers some distinct advantages in many superficial cancers to that of either radium or higher voltage roentgen radiation. There is less scarring, less atrophy and fibrosis of normal structures, and fewer latent radionecroses than in radium treated cases.

Cancers of marked infiltration and recurrent disease as a group are better controlled by higher voltages and heavier filtrations. Divided doses offer better opportunity for control of dosages and protection of normal structures.

Exposure to sunlight, wind, and cold in irradiated superficial cancers is a factor in producing late necrosis and infection, and is to be avoided.

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THE TREATMENT OF ENCEPHALITIS WITH THE ROENTGEN RAY

A PRELIMINARY REPORT*

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ENCEPHALITIS is an inflammation of the brain. The disease manifests itself in a myriad of symptoms and presents nomad characteristics which make differentiation from other neurological afflictions difficult. Encephalitis assumed a rôle of great importance subsequent to the influenza epidemic of 1918. It was believed that the filtrable virus productive of one caused the other.

The acute stage of encephalitis usually sets in as an upper respiratory infection and is soon followed by symptoms of cerebral localization. These may be lethargy, disturbances of the ocular apparatus, generalized muscular weakness and radicular pains. The spinal fluid may appear clear and show an increased number of lymphocytes, but frequently no alterations in cell content are evident.

A patient with an attack of acute encephalitis may recover completely, or slowly develop a chronic form of the disease. Subsequent to the influenza epidemic of 1918 many patients, apparently completely recovered, later at varying intervals exhibited evidence of chronic encephalitis, the most common syndrome closely resembling paralysis agitans or Parkinson's disease. The face is mask-like and lacking in spontaneity of expression; there is a doughy rigidity, giving way in passive movement by short cog-wheel jerks; tremors of the extremities often present at rest but absent momentarily on intention; rigidity of the musculature; body bent forward, forearms and hands semiflexed. The patient walks stiffly without arm swinging. He moves as one piece and turns en masse. Retropulsion and propulsion are evident especially when walking slowly. Speech is slow, monotonous and stiff. Increased salivation, tearing and sweating are present.

PATHOLOGY

Although any part of the brain may be involved, localization is most frequent in the basal ganglia. There is an inflammatory reaction in the perivascular or intraadventitial spaces with the formation of large lymphocytic cuffs about the blood vessels. The brain tissue itself may be infiltrated with the lymphocytes. The blood vessels are thickened, and the endothelial lining is swollen. As the process continues, the ganglion cells undergo permanent damage. In the chronic stage signs of inflammation are milder, but perivascular round cell infiltration may be seen in some areas.

RATIONALE FOR ROENTGEN THERAPY

Goldberg, Baker and Hurff[1] in 1934 presented the greatest stimulus for the trial of roentgen irradiation in the therapeusis of acute encephalitis. It seemed to them that the symptoms in the early stage of the disease were due to pressure or to circulatory disturbances produced by the perivascular lymphocytic infiltration; and since these cells were highly sensitive to irradiation, their rationale appeared logical and well taken. They reported the results of treatment of 3 patients in whom the effects were startling and beneficial. Goldberg[2] emphasized the negative results in the roentgen treatment of fully developed postencephalitic parkinsonism in contrast to the consistently satisfactory response of acute encephalitis. E. D. Friedman,[3] confirming Goldberg's experience in chronic encephalitis, referred to the pioneer work of Marburg and Sgalitzer[4] who also reported poor

* From the Radiation Therapy Service, Dr. Ira I. Kaplan, Director, and the Neurological Service, Dr. Foster Kennedy, Director.

prospects for relief. C. W. Schwartz[5] and his colleagues at the New York Neurological Institute pointed out that this form of therapy has little to offer in the chronic stage. They felt, however, that there was something to be gained in the acute phase by irradiation which might eliminate or minimize the usual sequelae.

Appreciating the essential pathological state in chronic encephalitis when permanent damage has been done to the ganglion cells, roentgen irradiation or any type of therapy should prove of no avail. Even if a persistent perivascular round cell infiltration does exist, as evidence of a chronic infectious process, the permanently destroyed ganglion cells cannot be reactivated, and the symptoms due to their disturbed function should linger. Nevertheless, the stimulus to the trial of roentgen therapy in chronic encephalitis was given by one of us (A. W.) who had the opportunity to observe a patient with chronic encephalitis following an attempt at suicide with carbon monoxide. Most of the symptoms of parkinsonism disappeared temporarily following this gas poisoning. The explanation offered was that carbon monoxide induced a vascular hyperemia and dilatation. That this effect may be induced by roentgen therapy is a fact. We deemed it advisable, therefore, to attempt small doses of roentgen rays over the basal ganglia in the hope of stimulating and maintaining for a time an active vascular dilatation sufficient to produce changes in the symptomatology.

CASES

Included in this small series are 9 patients with chronic encephalitis, varying in age from twenty-five to fifty-six years: 7 males and 2 females. That these were of long standing can best be appreciated by citing the duration of the illness, namely, eight, seven, seventeen, nineteen, six, one, seventeen, five and ten years respectively. Two patients had influenza in the epidemic of 1918; 1 had influenza in 1927. The typical familiar picture of Parkinson's disease was present in every case with the symptoms and signs enumerated previously. The objective criteria for improvement were easy of evaluation since alterations in drooling saliva, tremor, rigidity, anteropulsion and retropulsion were not difficult to ascertain.

TECHNIQUE

Attempts were made to utilize several techniques with variations in ray quality, size of fields, individual and total doses.

The following techniques were employed: with roentgen rays of 200 kv., filtered through 0.5 mm. Cu and 1 mm. Al, using open fields at 40 and 50 cm. distance, and striking the right and left lateral skull at one sitting:

I.	75–300 r—twice weekly	1 case
II.	75–600 r—twice weekly	3 cases
III.	50–300 r—twice weekly	3 cases
IV.	100–400 r—twice weekly	2 cases

(All these measurements are in air.)

During the period of observation and treatment, alterations in these techniques were made. Thus, with the same factors as outlined above, but utilizing 6 × 8 cm. portals at 50 cm. distance and directing the beam toward the basal ganglia:

I. Right and left temporal and suboccipital areas, 150–400 r—3 times weekly—3 cases
II. Open fields to the right and left skull, 150–400 r—twice weekly—3 cases
III. With 100 kv., and 4 mm. Al filter at 30 cm. distance, 1 case was given additionally 60–300 r, twice weekly, to the right and left skull, two areas being treated at one sitting.

RECAPITULATION OF TECHNIQUES

Rays generated at 200 and 100 kv. were used, the former filtered through 0.5 mm. Cu and the latter through 4 mm. Al, distances of 40 and 50 cm. Individual doses varied from 50 to 150 r and total doses varied from 200 to 800 r (all measured in air). The areas and fields varied from large

portals covering either side of the skull to 6 × 8 cm. fields directed toward the basal ganglia. The interval between treatments varied from every second to every fourth day.

RESULTS OF TREATMENT

In 7 patients epilation of the scalp hair was produced. Generally, in no one case was there any positive objective evidence of improvement. As cited previously, drooling saliva, oculogyric crises, tremor, rigidity, anteropulsion and retropulsion, etc., were the criteria judged in reaching these conclusions. In modification of these specific observations, one patient stated that for one day the tremors were absent, but recurred, another patient developed headaches during the course of treatment, but these disappeared when therapy was curtailed. One patient stated he felt better during the day when a treatment had been administered. This was a subjective statement.

ACUTE ENCEPHALITIS

In direct contrast to the results obtained with roentgen therapy of *chronic* encephalitis, we add 2 patients who, in the acute stages of the disease, exhibited favorable responses.

In a young boy aged seven a diagnosis of encephalitis was established because of an acute onset of fever, nausea, stupor, diplopia, and an increased spinal fluid cell count with 70 per cent lymphocytes. During the course of the illness, paralysis of the right internal and left external recti appeared, so that eye convergence was impossible. After subsidence of the acute symptoms the strabismus persisted. Strabismus disappeared following roentgen treatment with 200 kv. and 0.5 mm. Cu in doses of 75 r up to 500 r. This improvement was evident after the fourth treatment. He has remained entirely symptom free for fifteen months.

Another young patient of ten years was suddenly seized with fever and deep stupor which soon changed to bewilderment, impulsive action and violence. Several neurologists established a diagnosis of encephalitis. One month later, roentgen treatment was administered with 200 kv., in 50 r doses for a total of 400 r. After the sixth treatment, a startling change was apparent in his calm lucidity, a rapid return of appetite and generalized improvement.

DISCUSSION

Our original intention was to induce a vascular hyperemia in the basal ganglia by the administration of mild doses of roentgen rays. We were aware that repeated exposures would eventuate in ultimate fibrosis. However, it seemed reasonable to assume that if treatments were of sufficiently low intensity and given at infrequent intervals, this fibrosis could be avoided. Our negative results may have occurred because, in spite of our caution, the doses were too large and too frequent. We should not forget the patient who was being treated with 4 mm. Al filter at a 100 kv. potential who stated that always on the day of treatment, there was a feeling of well being. It may well be that a transient vascular dilatation was produced, and was manifesting a favorable effect.

It seems probable, therefore, that excessive doses would defeat the very purposes of therapy. It becomes obvious, too, that the future technique should involve smaller doses at longer intervals where a hyperemia will be evoked, and only after full regression should another dose be administered.

We must be very cautious in arriving at conclusions relative to treatment in the acute cases. In many instances the symptoms may resolve spontaneously. We present only 2 patients whose responses were satisfactory, and more promising than those recorded in the chronic disease.

CONCLUSION

In the small series of cases herein reviewed, with the mode of therapy, technique and dosage employed, we have found roentgen therapy to be without any beneficial effect upon the symptoms or signs of

chronic encephalitis. In two cases of acute encephalitis, the subsidence of symptoms following irradiation seemed to be directly related to this form of therapy.

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CLINICAL SYMPTOMS USEFUL AS A GUIDE FOR ROENTGEN THERAPY*

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THESE observations are based upon 47 cases of mastoiditis and 121 cases of post-nasal sinusitis. In the discussion of these cases I wish to establish three objectives that can be accomplished with fractional dosage of roentgen radiation. This study will include symptoms of actual cases and only such symptoms as can be relieved by the use of the roentgen rays.

Case 1. May 13, 1914. A. D., female, aged eight. The patient had suffered for seven days with severe pain. This pain began in the middle ear and on the second day had spread into the mastoid. During the third day occurred the rupture of the tympanic membrane, and with this rupture the pain in the middle ear was greatly relieved. The resultant free discharge from the middle ear was not accompanied by relief of the pain in the mastoid. An examination revealed a marked swelling over the mastoid. A diagnosis of acute mastoiditis with subperiosteal abscess was made. A mastoidectomy was advised, but was refused. The abscess was lanced, and this treatment relieved the tension of the external tissues. The pain in the mastoid, however, continued. A roentgen treatment of 30 ma-min. was given. The patient said the pain was less severe after this treatment, and on the next morning, after having slept a part of the night, she reported that the pain was markedly less. After the first five treatments all pain was relieved. Treatments at longer intervals were continued. The discharge from the ear canal became thicker for two days and then thinner and less abundant from day to day. By the fourteenth day of treatment the ear was dry and all symptoms were relieved. The patient was discharged. From the foregoing I learned of the analgesic effect of the roentgen ray.

No roentgenograms were taken of the above case, but in the 46 succeeding cases roentgenograms were taken of the mastoids, both before and after treatment. These roentgenograms showed that after the treatments further invasion of the mastoid cells had stopped. This condition was due, I believe, to the inhibition of the multiplication and motility of the bacteria. The increased phagocytosis of the bacteria present was indicated by the increased thickness and amount of discharge during the first two days of treatment; also by the subsequent thinning and lessened amount of the exudate from day to day until all bacteria present had been phagocytosed. At this time all discharge from the ear stopped.

In all the cases observed, the pain was noticeably less following each treatment, and it was usually relieved entirely after the fifth treatment. All discharge from the ear stopped in from ten to fourteen days.

As further proof of the results obtained, roentgenograms of actual cases are herewith submitted (Figs. 1, 2, 3, 4 and 5).

In the cases of infected mastoids shown in Figures 1, 2, 3, 4 and 5, I have demonstrated that with roentgen treatment, two things can be accomplished: (1) pain can be relieved; (2) multiplication and motility of bacteria can be stopped.

Utilizing the above results as a guide for roentgen treatment, I have treated 47 cases of mastoiditis and 121 cases of post-nasal sinusitis.

In post-nasal sinusitis, the two chief symptoms complained of are pain and the discharge of mucopurulent material. The pathological study of the mucous membrane and the underlying network of lymph cells of infected sinuses reveals bacteria implanted in all of the tissues of the membrane and lymphatics and often in the periosteal lining. With the bacteria so deeply implanted, drainage, suction, and antiseptic applications alone are inadequate. We have found that when drainage

* Read at the Fifth International Congress of Radiology, Chicago, Ill., Sept. 13–17, 1937.

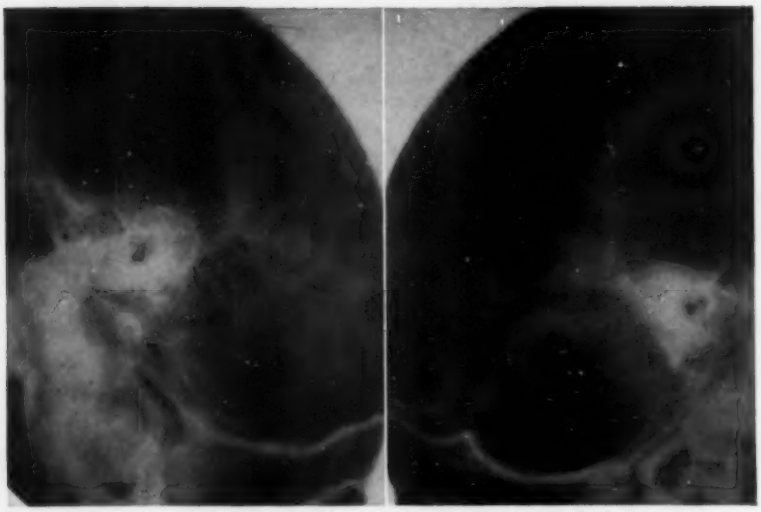

Fig. 1*A*. Case xi. N., aged seven. Roentgenograms taken on April 24, 1924, five days after the onset of the disease. While the left mastoid is clear, the right mastoid shows marked cloudiness of the cells of the antrum. Antral cells are filled with exudate and the cell walls are faintly outlined. A condition of acute purulent mastoiditis prevails in the antral cells. The anterior wall of the sigmoid sinus is quite well outlined. This is corroborative evidence of purulent mastoiditis. Cells in the tip of the mastoid are not clouded. The cells posterior to the sigmoid sinus are definitely hazy but the cell walls are not destroyed. This condition indicates simple mastoiditis in this area. The fact that the superior cell walls are not visible indicates acute purulent mastoiditis in this area.

is combined with roentgen treatment, very satisfactory results are obtained.

Case viii. April 9, 1935. Mrs. S., aged forty-two. Chief complaints were pain above eyebrows; pain in eyeballs and just in front of the hair line of the forehead; pain also in the left temporoparietal and occipital regions and in the back of the neck. Pains varied as to time and character but were much worse during an

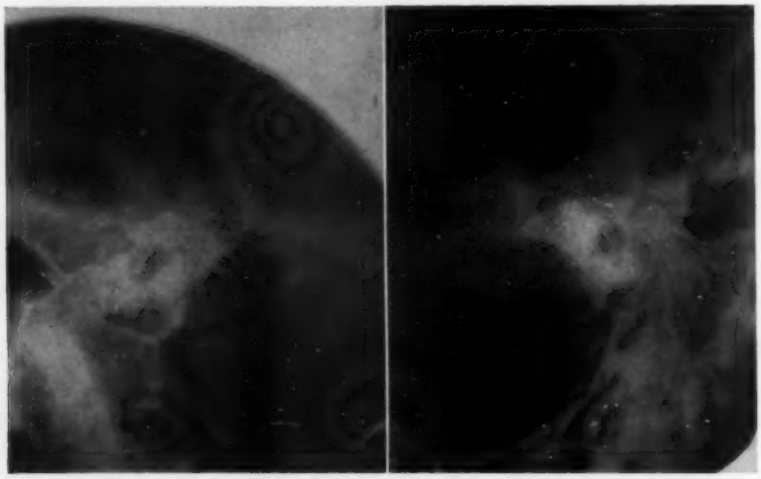

Fig. 1*B*. Case xi. Roentgenograms taken thirteen days after Figure 1*A*. Cloudiness of some of the antral cells is less pronounced. The anterior wall of the sigmoid sinus is not so definitely pronounced. Cells posterior to the sigmoid sinus are less hazy and the trabecular walls are more definitely outlined. Cells of the superior mastoid area are noticeably less hazy. The condition of all the mastoid cells shown definitely demonstrates that no further invasion or destruction of the trabeculae occurred after roentgen therapy was begun.

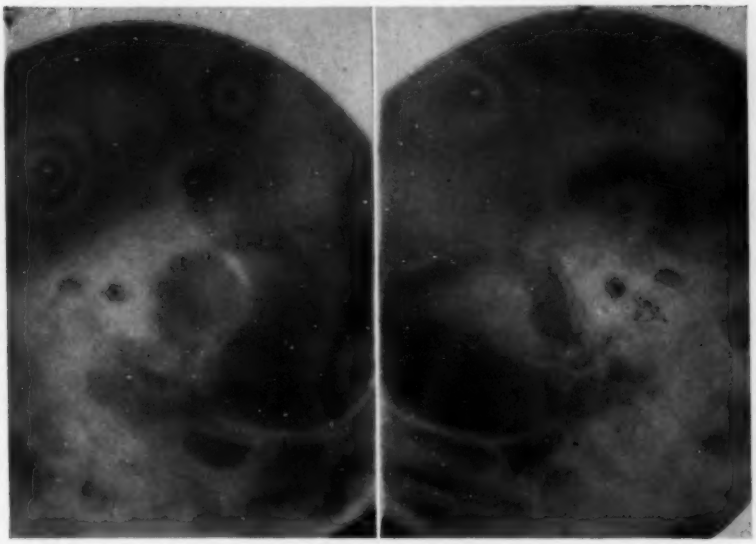

Fig. 2*A*. Case xiii. Patient J. Roentgenograms taken on July 12, 1924, three months and twenty-four days after the onset of the disease. The left mastoid is small and the cells are poorly outlined. This left mastoid is not normal, though the patient made no complaint of it. The right mastoid shows marked cloudiness in the cells of the antrum. The tip of the mastoid is slightly hazy. The anterior wall of the sigmoid sinus is clearly outlined. The whole lumen of the lateral and of the sigmoid sinus is quite well outlined. The cell walls overlying the sigmoid sinus are irregular in outline and for the most part have been destroyed and absorbed. The sinus itself is not infected. The cells posterior to the sigmoid canal are definitely filled with exudate and the cell walls are destroyed. The whole picture is that of subacute purulent mastoiditis.

acute cold. Patient was rarely ever entirely free from head colds. She often expectorated a lot of yellowish gray thick mucus. She tired easily and complained of general malaise. These symptoms had been troubling her for one year. Examination of the post-nasal sinuses revealed a bloody mucopurulent material present in the right and left frontal—anterior and posterior ethmoidal—and sphenoidal sinuses. Diagnosis: Acute exacerbation of subacute post-nasal sinusitis. No roentgenograms were taken of the sinuses. The treatment given was a combination of roentgen irradiation with drainage. After three treatments the pain

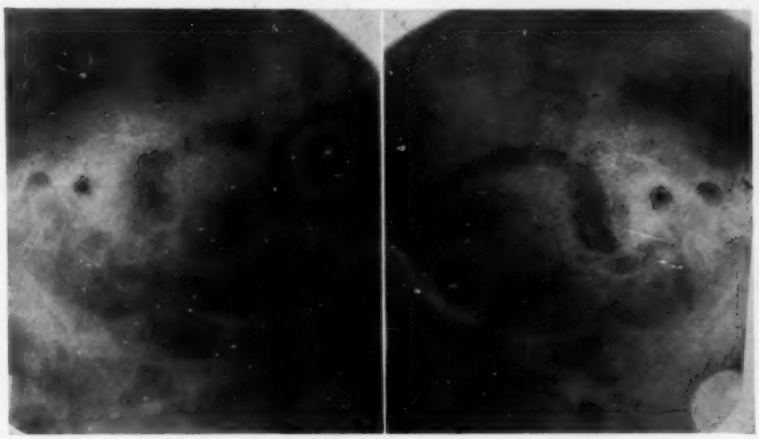

Fig. 2*B*. Case xiii. Roentgenograms taken one month later than Figure 2*A*. The antral area and the area posterior to the sigmoid sinus are definitely less cloudy and show signs of absorption of the exudate. The posterior canal wall is clearly seen. The superior cells of the antrum, though small, show signs of clearing.

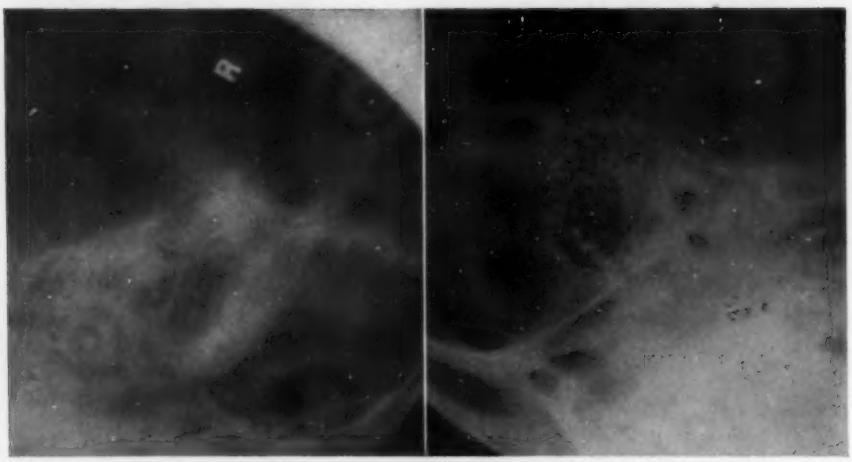

FIG. 3*A*. Case XLIII. Patient B. Roentgenograms taken on February 5, 1932, just before treatment was begun, show in the right mastoid a large area of cells filled with exudate. The fact that the cells for the most part are obscured gives indication of acute purulent mastoiditis. Note the bold contrast between the cell structure of the two mastoids.

was entirely relieved, and, after seven treatments, the bloody character of the discharge ceased. A total of fourteen treatments was given, after which all discharge stopped and the patient was entirely free of all the symptoms complained of.

In all of the 121 cases of sinusitis treated, no roentgenograms were taken of the sinuses. The diagnosis was made with the use of the Edgington method of evacuating the sinuses. The treatment given was, as before stated, a combination of roentgen irradiation with drainage. The pain, when present, was quickly relieved. The character of the bloody mucopurulent material changed and lessened in the amount from

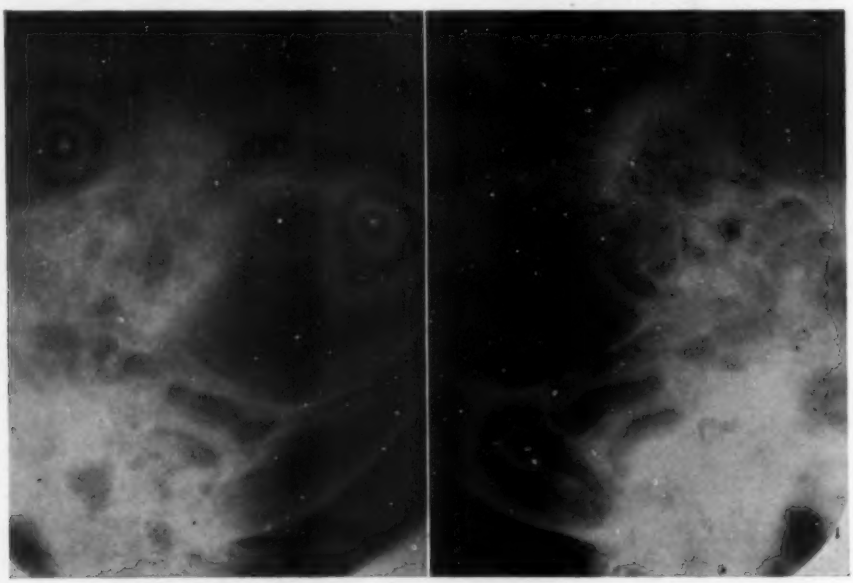

FIG. 3*B*. Case XLIII. Roentgenograms taken three months and twenty-two days after Figure 3*A*. The films show a recession of haziness in the area involved. This is evidence that no further involvement of cells took place after the treatment was begun. Fibrosis of the diseased tissues is being established.

day to day. From ten to fourteen treatments were usually required to relieve all symptoms.

A third symptom, that of clonic and tonic muscular spasm, which closes the ostium of any hollow viscera, can be relaxed, and the pain and obstruction relieved with roentgen treatment. Examples of this are certain forms of gallbladder colic, due to the tonic muscular closure of the ostium of the common bile duct; also certain forms of pylorospasm, etc.

In summing up the foregoing facts, I concluded that roentgen treatment accomplished three definite results, namely: (1) it stopped pain; (2) it relieved tonic muscular spasm; (3) it inhibited the multiplication and motility of bacteria.

With the above objectives accomplished and the roentgen irradiation maintained long enough, I believe that nature phagocytosed all pyogenic bacteria present and that the macrophagic cells eliminated the debris so that constructive metabolism could repair the damaged tissues.

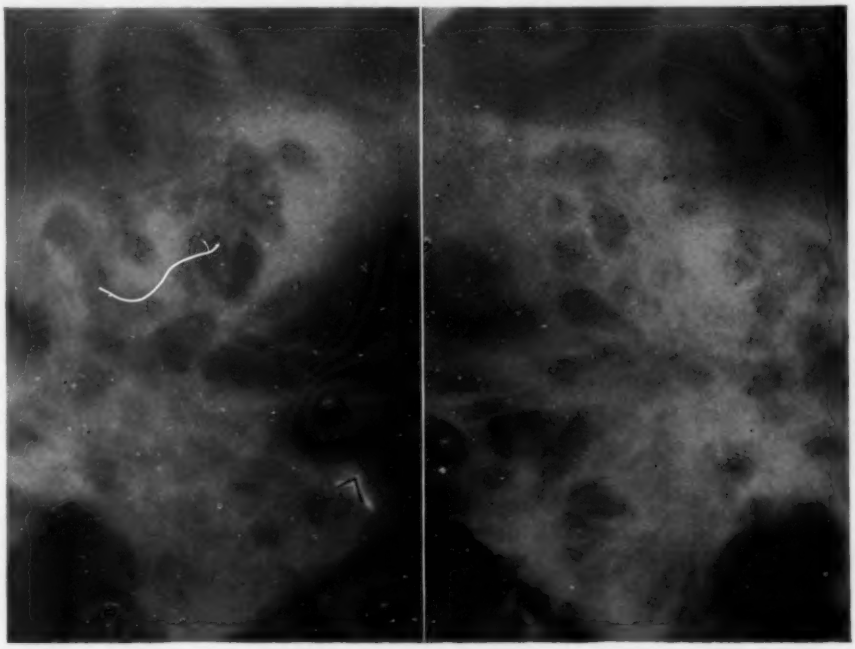

Fig. 4. Case xlvii. Patient B. Roentgenograms taken April 24, 1937, six days after the onset of pain in the right mastoid. The *right mastoid* shows a marked haziness of the antral cells, also of the cells superior and posterior to the sigmoid sinus. Although the cells are filled with exudate, the trabeculae are clearly shown. This is evidence that the trabecular walls have not been destroyed. In this case all pain was relieved after the fifth treatment, and in fifteen treatments all symptoms were relieved. The *left mastoid* sustained an acute attack of infection twenty years previous to April 24, 1937, and at that time a mastoidectomy was refused. Roentgen treatments were given to the patient with relief of all symptoms. He has had no trouble since and his hearing is good. The film shows a well marked pneumatic area overlying the sigmoid sinus, and overlying the lateral sinus are areas of bone-like appearance. It is evident that the mastoid cells which were not completely destroyed cleared up following roentgen treatment. The area of those that were destroyed has taken on a bone-like structure.

My record of 121 cases of post-nasal sinusitis and 47 cases of mastoiditis, successfully treated since 1914, has fully confirmed the conclusions arrived at in the treatment of the initial case, i.e., that roentgen treatment stops pain, relieves tonic muscular spasm and inhibits the multiplication and motility of germs.

Treatment has not been confined to the above two diseases, but it has been expanded to cover many acute and chronic

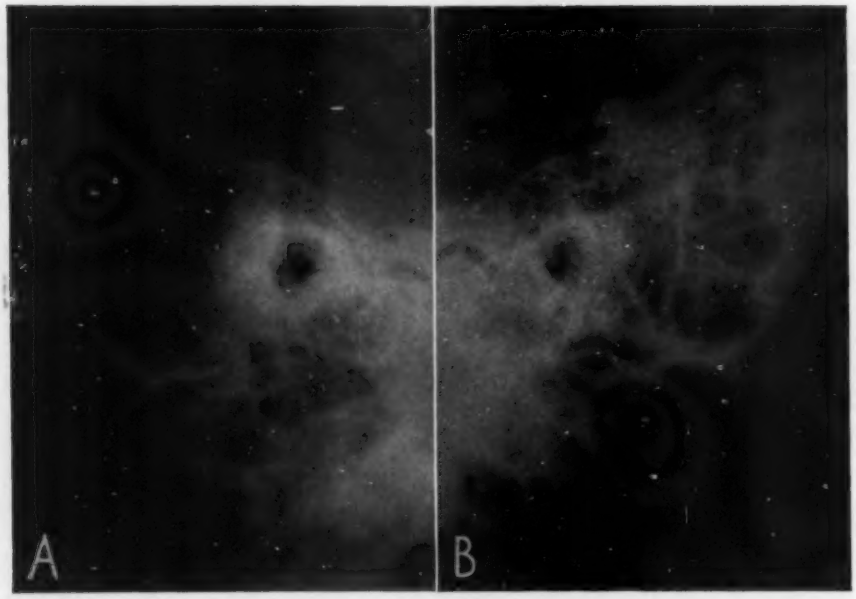

Fig. 5. Case xlviii. Patient S., aged forty-four. On December 21, 1936, this patient suffered an attack of otitis media and purulent mastoiditis. To relieve this condition a mastoidectomy was done on February 3, 1937. Although his major symptoms were greatly relieved, the patient continued to suffer more or less pain and tenderness. *A* is a roentgenogram taken on June 17, 1937. The marked haziness of the antral cells anterior and superior to the antrum, also of those just above the temporomandibular articulation, indicates the area of pain and tenderness. Using these clinical symptoms of pain and tenderness as a guide for roentgen therapy in this case, all of the symptoms were relieved by the administration of 196 r during a period of six days. *B* shows a normal mastoid with cells widely distributed, while *A* shows the area of the diseased cells which were not removed at the time of operation. This is in striking contrast to the quick and complete relief of all symptoms with roentgen treatment.

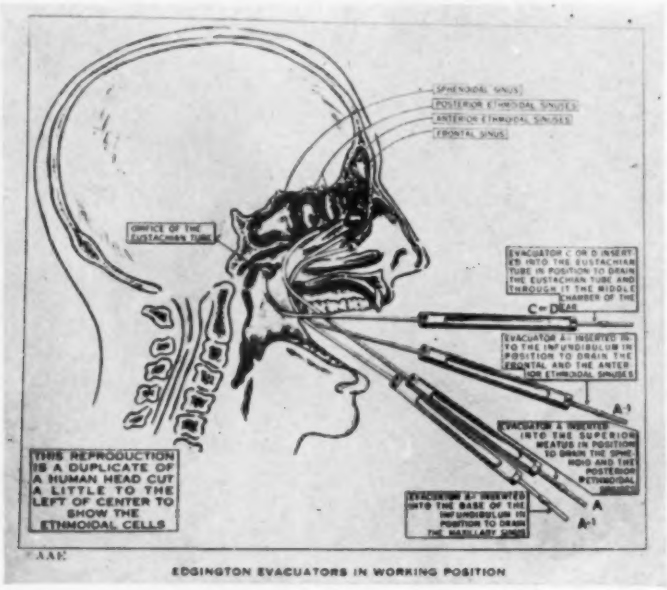
SPHENOIDAL SINUS
POSTERIOR ETHMOIDAL SINUSES
ANTERIOR ETHMOIDAL SINUSES
FRONTAL SINUS
ORIFICE OF THE EUSTACHIAN TUBE
C = DRAIN
A-1
A
A-1
THIS REPRODUCTION IS A DUPLICATE OF A HUMAN HEAD CUT A LITTLE TO THE LEFT OF CENTER TO SHOW THE ETHMOIDAL CELLS
EDGINGTON EVACUATORS IN WORKING POSITION

Fig. 6. Edgington evacuators in working position. This chart shows the method of draining the sinuses. If and when the mucopurulent material is evacuated, it is seen as it passes through the glass cylinder of the instrument. The treatments consist of drainage combined with roentgen irradiation.

inflammatory diseases in which one or more of the above three objectives were to be accomplished.

I have successfully treated the following with roentgen irradiation:

Carbuncles
Cholecystitis
Pulmonary tuberculosis
Tuberculous peritonitis
Myocarditis
Tonsillitis
Pharyngitis
Salpingitis
Arthritis
Prostatitis
Sprains of joints and muscles
Infected wounds
Pleurisy
Unresolved pneumonia
Herpes zoster
Early carcinoma of cervix uteri
Lymphadenitis
Septic sore throat
Actinomycosis of lungs
Epidermophytosis
Pylorospasm
Ulcers of the stomach
Ulcers of the duodenal cap
Painful abdominal adhesions
Appendicitis

The basic treatment used is as follows:

Mastoiditis:

Kilovolts (peak)	110
Ma.	5
Filter	5 mm. Al
T.S.D.	30.5 cm.
Dosage	30 r

Average number of roentgens to relieve pain, 150.

Average number of roentgens to relieve all symptoms, 300–360.

Exposures are given twice daily until all pain is relieved; after this, they are repeated every one, two, or three days until all symptoms are relieved.

Post-nasal Sinusitis:

Kilovolts (peak)	110
Ma.	5
Filter	5 mm. Al
T.S.D.	30.5 cm.
Dosage	30 r

Average number of roentgens to relieve pain, 90.

Average number of roentgens to relieve all symptoms, 300–420.

Exposures are given daily until the bloody character of the mucopurulent material obtained by drainage of the sinuses has ceased; then treatment is continued every two or three days until all symptoms are relieved.

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THE RHYTHM OF RADIATION EFFECTS

FURTHER STUDIES OF PROTRACTED EXTERNAL IRRADIATION IN THE TREATMENT OF NEOPLASMS OF THE UPPER RESPIRATORY TRACT*

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THIS report is a further study of the biological significance of the radiation quality and time intensity factors in the protracted external irradiation of neoplasms of the upper respiratory tract, based upon a clinical study of 175 cases. The aim of this investigation was:

1. To compare the biologic effects on the human skin and mucosa of 200 kv. roentgen rays filtered with 0.25, 0.5 and 2 mm. copper respectively.
2. To compare the biologic effects of roentgen rays with those of gamma rays.
3. To outline the normal variations of range of radiation epithelitis and epidermitis.
4. To study the optimum exposure time for a specified dose by comparing small and large radium packs.
5. To study the rate of regression of a tumor and its influence on the method of treatment.

TABLE I

TECHNIQUES EMPLOYED IN THIS STUDY

	Roentgen Rays			Radium	
				Large Radium Pack	Small Radium Pack
	200 kv.; 4 to 10 ma.			5,000 mg.	100 mg.
Primary Filter	0.25 mm. Cu.	0.5 mm. Cu	2 mm. Cu	0.5 mm. Pt+5 mm. Pb (6 mm. Pb Equiv.)	2.5 mm. Pt (5 mm. Pb Equiv.)
Half-value layer	0.57 mm. Cu	0.9 mm. Cu	1.8 mm. Cu		
Distance	60 cm.			6 cm.	
Portal	10×15 cm.			8×10 cm. (Confined Beam)	7×9 cm. (Open Beam)
Daily dose	200 r (including back-scattering) to each of two portals			5,000 mg-hr. To one alternate area each day	2,400 mg-hr. To each of two portals

* Read at the Fifth International Congress of Radiology, Chicago, Ill., Sept. 13–17, 1937.

6. To observe the effects of protraction of daily treatments with smaller doses over periods extending to three and one-half months.
7. To study the phenomenon of periodicity, and its possible applications to the treatment of malignant tumors.

TECHNIQUES

The following techniques were employed (Table 1):

1. *Roentgen rays*—200 kv.; 4 to 10 ma.; 60 cm. distance; 10×15 cm. portal (150 sq. cm.); filtration, (*a*) 0.25 mm. copper and 1 mm. aluminum, (*b*) 0.5 mm. copper and 1 mm. aluminum, (*c*) 2 mm. copper and 1 mm. aluminum.

Two lateral portals were utilized in all patients whether treated with radium pack or roentgen rays. Those patients who were treated through three portals were excluded from this study.

The daily dose was 200 r (including back-scattering) to each of two portals. Treatments were given six days a week. The milliamperage ranged from 4 to 10; and the intensity varied from 5 r/min. to 20 r/min. (in air). It is our impression, based upon clinical studies of the daily time factor (see section on small radium pack), that there is little or no detectable clinical difference in the biologic effect on humans between these two intensities.

All doses in this paper are expressed in roentgens including back-scattering. The routine measurements were made with the ionization chamber in air, and the dose then expressed to include back-scattering, using the conversion tables by Braestrup.

One size portal (10×15 cm.) was employed in all cases, regardless of the dimension and location of the lesion, in order to reduce the number of variables to a minimum. This is an admittedly large field, but its use permitted the inclusion of a large number of cases in this series. Only 3 patients were treated with roentgen rays filtered with 0.25 mm. copper, because this ray quality seemed to jeopardize unduly the chance of recovery, though it yielded information pertinent to this study.

2. *Five-gram radium pack*—0.5 mm. platinum and 5 mm. lead filtration; 6 cm. distance; 8×10 cm. portal (80 sq. cm.). The daily dose was 5,000 mg-hr. to one area. This rate of administration was chosen because it was found to produce epithelitis and epidermitis reactions of the same order as those produced with roentgen rays.

3. *Double small 100 mg. radium pack*—2.5 mm. platinum filtration; 6 cm. distance; 7×9 cm. portal (63 sq. cm.). The daily dose was 2,400 mg-hr. to each of two neck regions.

The portal of the small pack measured 1 cm. less on each side than the large pack, because the larger bulk of tissue irradiated by the non-collimated beam of the small pack contributed a greater amount of back-scattering in the tissues and equalized the depth dose.

METHOD OF PROCEDURE

Each case is recorded in graphic form (see Fig. 1). This graph is based on tri-weekly observations of the reactions in the skin and mucosa, and of the percentage shrinkage of the tumor. It is purely a clinical record and, as such, is subject to observational errors. All analyses and conclusions in this study are based on these graphs. The most definite points on the reaction curves are the onset of the epithelitis and epidermitis, the day they reach a second degree intensity, and the day they heal. The intensity of the reaction beyond a second degree can best be measured by observing the length of time required for healing and the nature of healing.

Percentage shrinkage curves are rather hard to construct because of the difficulty of measuring the volume of different shapes, and changing shapes.

COMPARISON OF ROENTGEN RAYS FILTERED WITH 0.25, 0.5 AND 2 MM. COPPER

The 20 per cent individual variation observed in the skin exposed to a single threshold erythema dose becomes so much greater when the radiation is fractionated

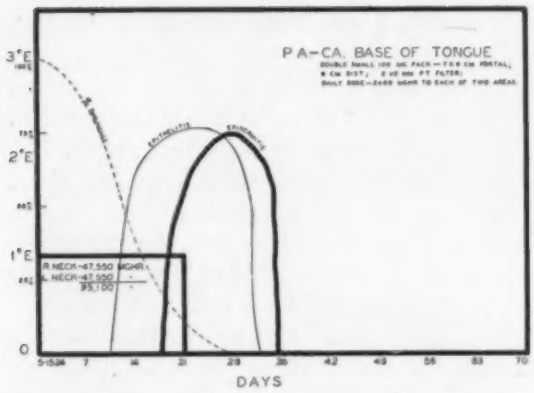

Fig. 1. Reaction curves of a typical case of a massive bulky, anaplastic carcinoma of the posterior third of the tongue and filling the oropharynx. It was treated with the double small 100 mg. pack technique (see Fig. 15), the radium being applied continuously for twenty-one days and administering a total dose of 95,000 mg-hr. The epithelitis and epidermitis are typical reactions, following each other in consecutive, overlapping order and remaining at a second degree intensity for approximately two weeks. The lesion was radiosensitive, reaching 50 per cent in size on the twelfth day, and disappearing completely on the twenty-seventh day. The patient has been free of disease since May, 1934.

and protracted that comparisons of different techniques require hundreds of cases in order to obtain typical average pictures.

Only in the first three weeks of treatment are the reactions consistent enough to provide standards for comparison. Thereafter the normal variations of the reactions occupy so wide a range as to render comparisons unfeasible.

For the first comparative study, we have utilized the first seventeen days of treatment, in those patients who have received six treatments a week (omitting only Sundays). Many cases were excluded because they missed one treatment. This was necessary because each patient reacts to radiation differently; in some, a rest period of more than one day a week may be significant, in others not so.

Epithelitis. In Figure 2 are traced all epithelitis curves of 0.5 mm. copper cases. These patients were treated six days a week up to the seventeenth day. On the tenth day, they had received a total dose of 3,600 r (including back-scattering). On the seventeenth day, they had received a total dose of 6,000 r. Taking into consideration at least a seven day lag, we can assume an accurate picture up to the twenty-fourth day for purposes of comparison. This chart presents therefore an accurate picture of the day of onset of epithelitis; the day it reaches a second degree reaction, and also indicates the extent of individual variations.

The day of onset of epithelitis is fairly consistent, occurring around the tenth day. The mathematical averages and the modal groups coincide (see appendix). As the reactions become more intense there is a wider dispersion of the curves between the extremes of the range.

The heavy line represents the central tendency or the mathematical average of the epithelitis up to the time it reaches a second degree. This central tendency curve was taken not only from a study of the arithmetic mean, but also the median, and the mode (see appendix). This curve representing the mathematical average has been transferred to Figure 6.

Figure 3 has been obtained in the same way as Figure 2 and represents the epithe-

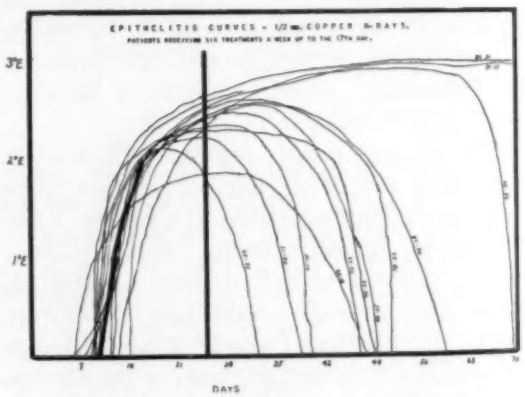

Fig. 2. Epithelitis curves of 0.5 mm. copper cases. Total dose on the tenth day was 3,600 r; and on the seventeenth day 6,000 r. The comparison of the curves is based only upon the first twenty-four days, because after that, the occasionally missed treatments introduced irregularities in the dosage rate, which prevented accurate comparisons. The heavy line represents the mathematical average curve of onset of epithelitis.

litis curves of those cases treated with roentgen rays filtered with 2 mm. copper. Here a lesser degree of uniformity is observed. The heavy line indicating the mathematical average is situated behind the modal or most common group, due to the pull exerted upon it by the large number of cases whose epithelitis commenced late, or never reached a second degree intensity (9 out of 19).* This seems to indicate that the shorter the wave length, the greater is the range of individual variation. This fact is further corroborated by the observations of the wide variety of reactions to treatment with radium gamma rays (see Figs. 11 and 12). Comparison of Figure 2 with Figure 3 demonstrates that all the 0.5 mm. copper reactions reached a second degree intensity whereas many of the 2 mm. copper reactions failed to do so.

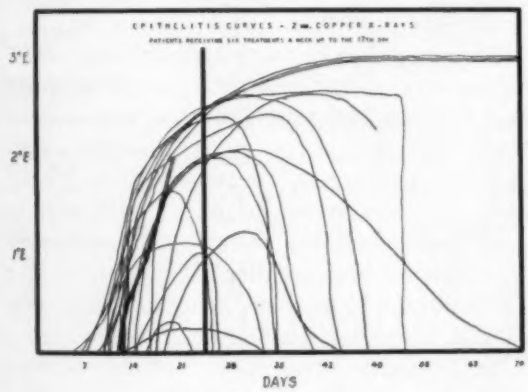

Fig. 3. Epithelitis curves of 2 mm. copper cases. All factors were the same as in Figure 2. Note the greater individual variation and the large number which failed to reach a second degree intensity, indicating a lesser destructive effect. The heavy line represents the mathematical average curve.

This suggests that the shorter the wave length, the less biologically effective is the roentgen, as far as skin and mucosal reactions are concerned. This is consistent with the fact that radiations of shorter wave lengths require a larger number of roentgens for an erythema dose.

*The mean deviation (see appendix) for the 0.5 mm. copper epithelitis curves is small, namely 1.9 for the day of onset, and 1.7 for the day it reached a second degree. It is larger for the 2 mm. copper curve, 3.4 and 4.2 respectively (see Table IV). Coutard found that the epithelitis (2 mm. copper filter) reached a second degree intensity on the thirteenth day fairly constantly, with varying time intensity factors and with doses of a generally larger order than ours. Our curve reached a second degree intensity on the twentieth day, and there was considerable individual variation.

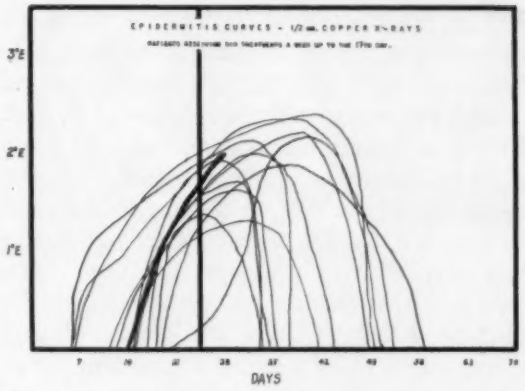

Fig. 4. Epidermitis curves of 0.5 mm. copper cases. The heavy line represents the mathematical average curve.

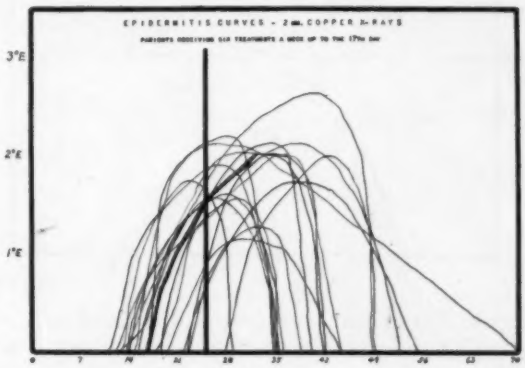

Fig. 5. Epidermitis curves of 2 mm. copper cases. The heavy line represents the mathematical average curve.

Epidermitis. In the same groups of cases discussed above, the epidermitis curves have been analyzed and three types of averages obtained: arithmetic mean, median and mode. These three averages were consolidated into a single average curve, indicated by the heavy line in Figures 4 and 5 (also see appendix).

The mean deviations as well as the range of distribution of the epidermitis curves are much greater than those of the epithelitis curves (see appendix), rendering less accurate the attempt to calculate a typical epidermitis curve.

The mathematical average epidermitis curve for 0.5 mm. copper commenced on the fourteenth day and reached a second degree intensity on the twenty-eighth day. Five out of twelve reactions failed to reach a second degree. The average epidermitis curve for 2 mm. copper commenced on the sixteenth day, and reached a second degree intensity on the thirty-second day. Coutard's figure is the twenty-sixth to the twenty-eighth day for the second degree epidermitis. Ours was not a constant figure

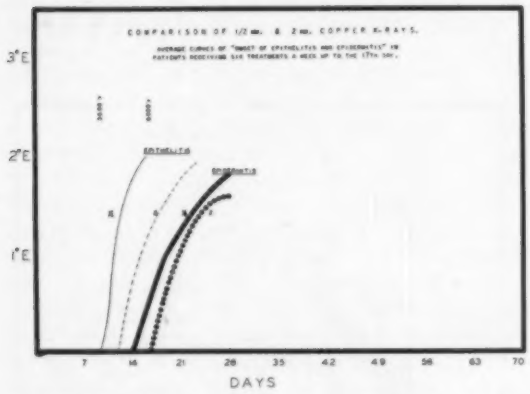

Fig. 6. The four average curves of onset of epidermitis and epithelitis have been transferred from Figures 2, 3, 4 and 5 to the above chart. It is observed that the epithelitis produced with roentgen rays filtered with 2 mm. copper, when compared with that of 0.5 mm. copper, appears later, reaches a second degree intensity later, and has a wider range of individual variation. The same is true of the epidermitis curves. It is also observed that epidermitis curves in general have a wider range of individual variation than epithelitis curves. Also, the more intense the reaction is, whether it be epithelitis or epidermitis, the smaller is the range of individual variation.

as 8 out of 17 cases failed to reach a second degree intensity, whereas Coutard states that his figure is rather constant.

The four average curves taken from Figures 2, 3, 4 and 5 are plotted for the purpose of comparison in Figure 6.

It is observed that the epithelitis produced by roentgen rays filtered with 2 mm. copper, when compared with that of 0.5 mm. copper, appears later, reaches a second degree intensity later, and has a wider range of variation.

The same is true of epidermitis curves: roentgen rays of the shorter wave length produce reactions that appear later, and reach a second degree intensity later than those of the longer wave length roentgen rays.

When the comparison is made on the basis of hypothetical typical average curves instead of mathematical averages (see appendix), the results are substantially the same except that the epithelitis curves of 0.5 mm. and 2 mm. copper both commence on the ninth day, but from then on, as the reactions increase in intensity, the 2 mm. copper epithelitis curves are retarded in appearance so that by the time they reach a second degree intensity the hypothetical typical average curves have the same relationship to one another as the mathematical average curves.

When average curves of only those patients whose reactions reached a second degree intensity were compared the conclusions were the same.

Only 3 patients were treated with 0.25 mm. copper filter, but their reactions were fairly characteristic. One case received a total dose of 3,200 r in twelve days, and another 4,000 r in fourteen days. These patients received only four treatments a week instead of six. Nevertheless with this dose, which was smaller than any of the 0.5 mm. copper or 2 mm. copper cases, and with a longer time between treatments, both patients attained a second degree epithelitis.

The above comparison is concerned only with the onset of the reactions and the time they reached a second degree intensity. It gives a fairly accurate picture of the reactions during the first three weeks of treatment. The most impressive fact observed is the wide range of individual variations with the exception of the 0.5 mm. copper epithelitis curves. There is also an implication in the curves that the onset and ascent of these reactions is influenced by the wave length of the radiation employed, in that the softer rays produce earlier and more acute reactions.

Another comparison between 0.5 and 2 mm. copper filtered roentgen rays was ob-

tained by plotting the reaction curves of those cases which received a total dose of 8,000 to 8,160 r delivered over a period of twenty-four to twenty-nine days for 0.5 mm. copper, and twenty-one to twenty-six days for 2 mm. copper. This variance in days weakens the accuracy of this comparison, but was necessary in order to obtain a sufficient number of cases for each group. Once again are noted the wide individual variations; for example: (a) in Figure 7 the smallest and largest epithelitis reactions were produced by the same dose, i.e. 8,160 r delivered in twenty-five days; (b) in Figure 8 the largest epidermitis reaction was produced by a small dose: 8,000 r in twenty-seven days, and the smallest reaction was produced by a larger dose: 8,160 r in twenty-four days. However, it will be observed that the range and dispersion of the epithelitis onset curves in Figures 7 and 9 are similar.

As in the previous comparison groups, the epidermitis onset curves revealed a wider range of normal individual variation than the epithelitis curves.

During the destructive phase (see Figs. 7 and 9) which occupies approximately the first four weeks, the reactions vary only moderately. During the later or healing phase, the individual variations become enormous.

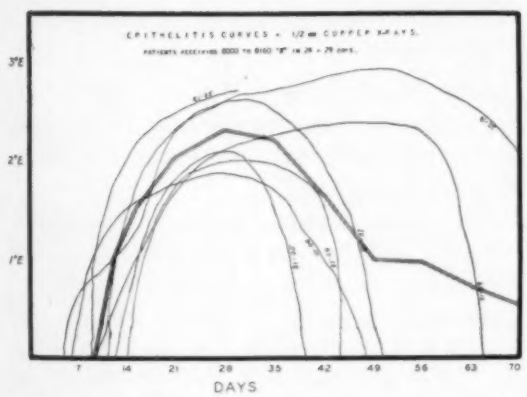

Fig. 7. Complete reaction curves in a group of 0.5 mm. copper cases which received approximately the same total dose in the same period of time. Note the wide range of individual variations, i.e. the largest and the smallest reactions were produced by 8,160 r delivered in twenty-five days. Note further, that during the destructive phase, there is a tendency toward constancy of reactions, whereas during the healing phase, the reactions vary considerably. The heavy line indicates the average curve.

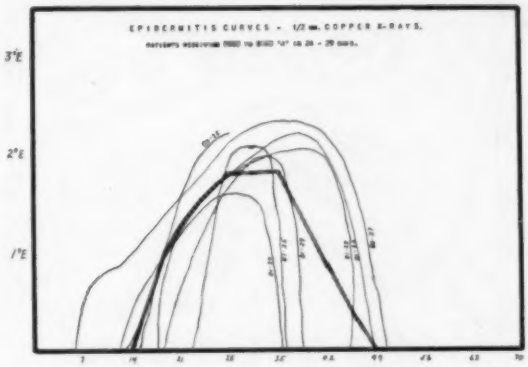

Fig. 8. Complete epidermitis curves in the same group of cases as in Figure 7. Note the greater range of individual variation as compared with the epithelitis curves (same observation as in Fig. 6). The heavy line indicates the average curve.

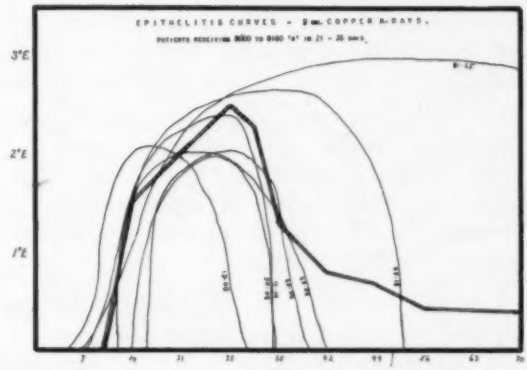

Fig. 9. Complete epithelitis reaction curves in a group of 2 mm. copper cases receiving the same dose as in Figure 7. Note once again that the onset of the reactions occurring during the destructive phase is more constant than the descent of the curves during the healing phase. The heavy line represents the average curve.

When the curves of this group are reduced to mathematical averages and compared (Fig. 10), they are found to be fairly parallel. The samples of cases employed are too few in number to permit any accurate conclusion, save that when roentgen rays are employed, the epithelitis reactions are more severe than the epidermitis reactions.

The observed variations in biologic reaction with different roentgen-ray qualities

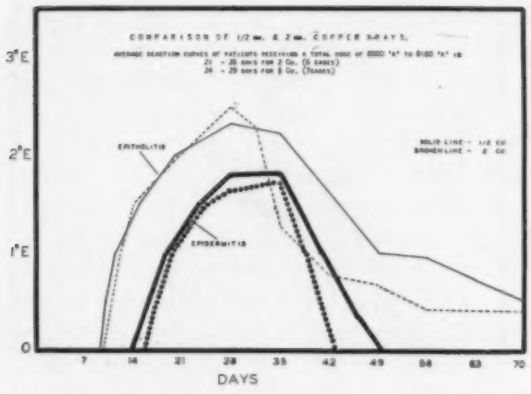

FIG. 10. The average reaction curves from Figures 7, 8 and 9 have been transferred to the above charts. The small number of cases permits only one definite conclusion: when roentgen rays are employed, the epithelitis reactions are more severe than the epidermitis reactions.

can hardly be accounted for by the difference in depth dose variations, which are only a few per cent. Therefore we are inclined to place greater significance upon the ray quality factor.

COMPARISON OF ROENTGEN AND GAMMA RAYS

The existence of a difference between the biologic effect of roentgen and gamma rays is still a debatable question. Experiments with biologic media, such as the eggs of sea urchins or fruit flies, indicate no differential effect due to wave length other than variations explained by differences in absorption and scattering.

Comparisons based on observations of humans are difficult because of the individual variations of patients. Nevertheless, a practical clinical comparison between roentgen and radium techniques is feasible.

Evidence pointing to a difference between gamma and roentgen rays is found in the low incidence of late carcinoma in radium burns as compared with the high incidence following roentgen burns. A further difference is observed clinically by administering subintensive doses such as a skin erythema dose. With this dose, the erythema produced by gamma rays appears at a later date than the erythema from roentgen rays.

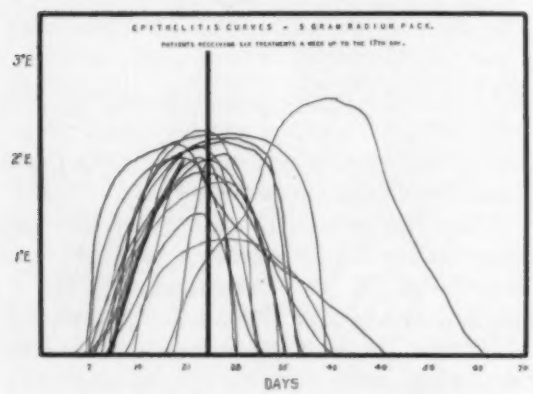

FIG. 11. Epithelitis curves of 5 gram pack cases. The total dose at the end of the tenth day was approximately 45,000 mg-hr., and at the end of the seventeenth day 75,000 mg-hr. The heavy line represents the average curve.

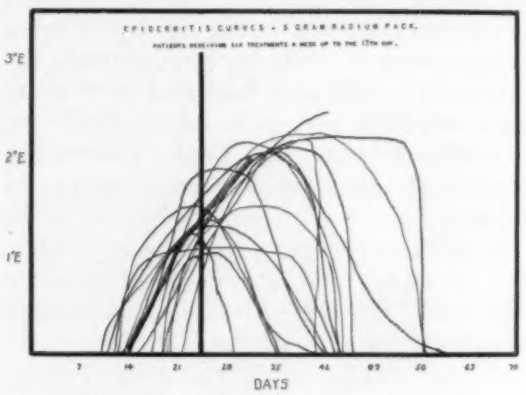

FIG. 12. Epidermitis curves of the same 5 gram pack cases as in Figure 11. The heavy line represents the average curve.

The reaction curves of onset of epithelitis and epidermitis were plotted (Figs. 11 and 12) for those patients who received 5,000 mg-hr. of radium each day to one alternate area, six days a week for at least the first seventeen days. At the end of the tenth day, approximately 45,000 mg-hr. total dose had been delivered to two portals; and at the end of the seventeenth day, approximately 75,000 mg-hr. total dose had been delivered to two portals. These doses are approximate because a slight latitude of one treatment more or less in the entire series was permitted in order to obtain enough cases to provide an analyzable picture.

The mathematical average onset curve of the epithelitis and epidermitis produced by radium actually commences on the tenth and fourteenth days respectively, instead of commencing later than the fourteenth and sixteenth days respectively (the dates for 2 mm. copper), as would be expected from the applied principle: The shorter the wave length, the later is the onset of reaction. The gamma-ray onset curves coincide with the 0.5 mm. copper filtered roentgen-ray curves. As the gamma-ray curves approach a second degree intensity, the reactions become delayed and the curves resemble the 2 mm. copper roentgen-ray curves (Fig. 13).

When the mathematical average of only those onset curves which reached a second degree were obtained (8 out of 15 epidermitis curves, Fig. 12, and 4 out of 15 epithelitis curves, Fig. 11) the result was the same.

When the curves representing the "hypothetical typical average case" were obtained and compared with similar roentgen-ray curves, the same conclusions were evident.

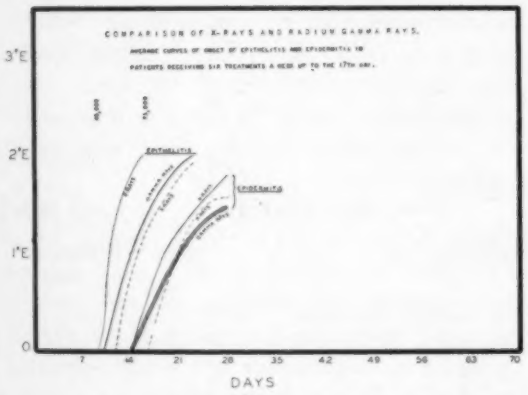

Fig. 13. Composite chart of onset of reaction curves. The fine lines are the roentgen-ray epithelitis and epidermitis curves transposed from Figure 6. The heavy lines are the 5 gram pack average reaction curves taken from Figures 11 and 12. Note that the gamma-ray reactions do not occur later than the roentgen-ray reactions, as might be expected on the basis of experiences with skin erythema tests. The fact that the reactions produced by the three ray qualities occur at about the same time suggests that fractionated irradiation produces such an intense effect that the destructive phase (with tendency toward constancy) dominates the picture and overwhelms the more delicate biological phenomena observed when a comparison is made using only a single skin erythema dose.

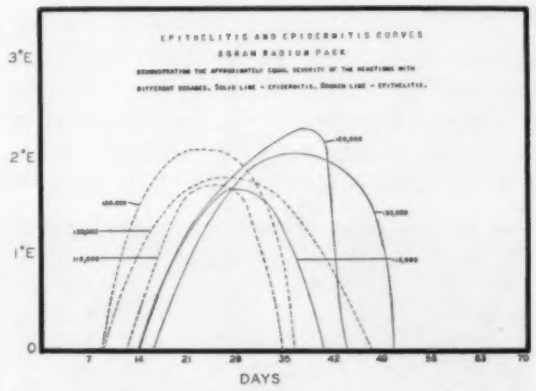

Fig. 14. Complete epithelitis and epidermitis reaction curves of three groups of patients treated with gamma rays as follows: those receiving total doses of (*a*) 110,000 mg-hr. in nineteen to twenty-six days, (*b*) 120,000 mg-hr. in twenty-three to twenty-nine days, and (*c*) 130,000 mg-hr. in twenty-seven to thirty-four days. The groups were separated because it would be inaccurate to attempt to express all of them in a single average curve. Note that though the gamma-ray epidermitis reactions (skin effects) are of the same order as the roentgen-ray epidermitis reactions (Fig. 10), the gamma-ray epithelitis reactions (biological effects in the depth) are less intense then the roentgen-ray reactions. This is probably due chiefly to the smaller depth dose of gamma rays. The solid lines represent epidermitis curves; the broken lines epithelitis curves.

To summarize, the time of onset of the epithelitis and epidermitis due to radiation from different qualities of roentgen rays is in inverse ratio to the wave length. The reactions from radium gamma rays, though the techniques are not strictly comparable, parallel those of 0.5 mm. copper roentgen rays as far as their time of onset is concerned; and parallel those of 2 mm. copper roentgen rays as they approach a second degree intensity. A possible explanation is that the daily, fractionated doses constitute such an intense effect that the destructive phase (with its tendency toward constancy) dominates the picture and overwhelms the more delicate biological phenomena observed when a comparison is made using only a single skin erythema dose.

A further difference between the reactions of roentgen and gamma rays is the fact that the epithelitis reactions produced by gamma rays tend to be less intense than those of roentgen rays. This difference can be illustrated by studying another aspect of these reactions. Figure 14 contains the mathematical average epithelitis and epidermitis curves of patients treated with the 5 gram radium pack. There are three groups of cases: (a) 11 patients receiving a total dose of 100,000 to 110,000 mg-hr. to two portals in nineteen to twenty-six days; (b) 7 patients receiving 120,000 mg-hr. in twenty-three to twenty-nine days; (c) 4 patients receiving 130,000 mg-hr. in twenty-seven to thirty-four days. Compare this chart for radium with a similar chart for roentgen rays (10). Note that in patients treated with doses of radium producing epidermitis reactions of the same order as roentgen rays, the gamma-ray epithelitis reactions are found to be slightly less intense than the gamma-ray epidermitis. Note further, that, though two of the three radium epidermitis curves are greater than the roentgen-ray epidermitis curve, nevertheless the radium epithelitis curves are less intense and of shorter duration than the roentgen-ray epithelitis curves.

Fig. 15. Technique of application of double small packs. A new helmet is made for every patient by means of placing adhesive strips on a gauze bandage base, and then incorporating the cardboard boxes in the helmet. A hole is cut out of the top and rear of the helmet for aeration. They may be readily removed to permit washing.

Therefore, generally speaking, roentgen rays produce epithelitis reactions of a greater magnitude than their epidermitis reactions, whereas gamma rays produce epithelitis reactions of the same or lesser magnitude than the epidermitis reactions. This is probably due to a great extent to the smaller depth dose of gamma rays.

THE SMALL RADIUM PACK

Though relatively few patients (14 in number) were treated two years ago or prior with the small radium pack technique (Fig. 15), the fact that 50 per cent, or 7 patients, are alive suggests the efficacy of this mode of therapy, especially since the lesions treated were either advanced, or radioresistant. It is possible that further experience will confirm our impression that continuous therapy with small radium packs is the most effective type of external irradiation.

Theoretically, continuous, twenty-four-hour-a-day exposure is the most ideal type of external irradiation because it bombards every cell during parthenogenesis over a period of three to four weeks. However its superiority over other types of external irradiation is not as great as the experimental evidence, upon which the law of Bergonié-Tribondeau is based, might indicate.

The small radium pack provides, among other things, information concerning the optimum time duration of each treatment. With this technique a daily dose of 2,400 mg-hr. is administered to each of two portals in twenty-four hours, whereas the 5 gram pack gives a similar dose in only one hour.

To compare the large and small pack techniques, groups of cases were employed

wherein similar reactions were produced by different doses delivered over a similar number of days. In Figure 16, the thin lines indicate the average reaction curves in 7 cases treated with the 5 gram pack, receiving an average total dose of 105,000 mg-hr. to two portals delivered in nineteen to twenty-four days. The heavy lines represent the average reaction curves of 7 cases treated with double 100 mg. packs delivering an average dose of 87,000 mg-hr. in eighteen to twenty-one days. These were the best comparable groups of reactions available. The excursions of the small pack reactions are somewhat greater than the large pack reactions. This difference is neutralized by the fact that large pack treatments were given over slightly longer periods of time which would tend to reduce the intensity of the reactions.

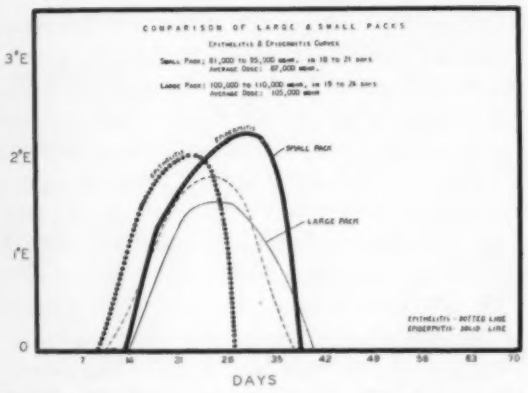

Fig. 16. Average reaction curves of 5 gram and double 100 mg. radium packs. Observe that with the continuous irradiation of the small packs, a dose of 87,000 mg-hr. will produce slightly more intense reactions than 105,000 mg-hr. delivered by the 5 gram pack in fractionated doses. This ratio of doses is 4:5 and represents the quantitative superiority of twenty-four hour-a-day exposure time as compared with one-hour-a-day exposure time.

This comparison indicates that over a similar period of time and with the same daily dose, the small pack will produce, with a total dose of 87,000 mg-hr., reactions of epithelitis and epidermitis similar to those produced by 105,000 mg-hr. with the large pack. This is a ratio of 4:5 and may be expressed in another fashion:

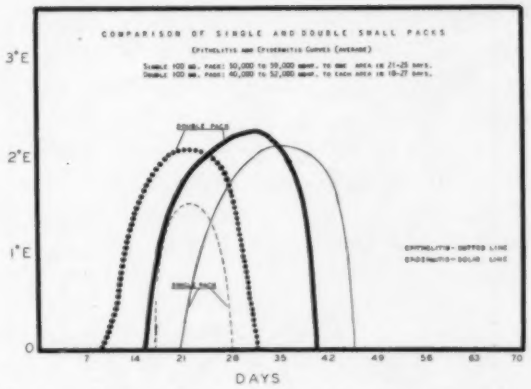

Fig. 17. Comparison of a single unilateral, and a double 100 mg. pack. Note that the single pack reactions appear later, and that its epithelitis is less intense and has a shorter excursion. This indicates that the time of appearance of the epithelitis and epidermitis is a function of the daily dose and varies with it, rather than being a constant natural phenomenon evoked by varying doses of radiation.

When comparing the effects of various treatment exposure times: $\frac{1 \text{ hour}}{24 \text{ hours}}$ = (in order to obtain the same reactions) $\frac{100\% \text{ of an arbitrary dose}}{80\% \text{ of the above dose}}$.

In other words, twenty-four-hour-a-day exposure time is 20 per cent more effective than one-hour-a-day exposure time. These figures are the same as the ones obtained by us previously in comparing the single 100 mg. radium pack with the 5 gram pack treating one area.

The clinical importance of the law of Bergonié-Tribondeau is shown to be valid, though to a much smaller extent than the original experiments indicated.

COMPARISON OF SINGLE AND DOUBLE 100 MG. PACKS

The mathematical average reaction curves of the single unilateral 100 mg. radium pack are compared with those of the double, bilateral 100 mg. packs (see Fig. 17). The epidermitis curves are comparable in excursion except that the single pack epidermitis, in all its phases, occurs

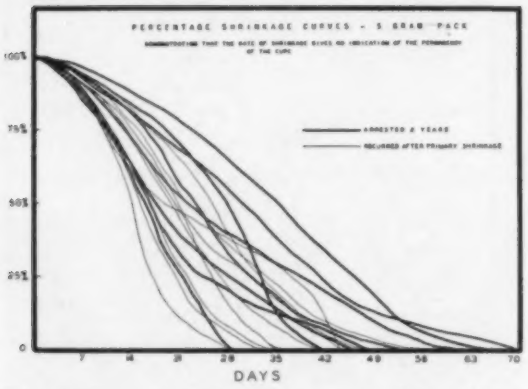

Fig. 18. Percentage shrinkage curves of those lesions which attained apparently complete primary regression after treatment with the 5 gram pack alone. The heavy lines represent those lesions which were arrested for two years or longer. The fairly even distribution of these curves indicates that examination of the rate of shrinkage of the tumor which has apparently regressed primarily gives little indication as to the permanency of this regression.

five days later than the double pack reaction. The epithelitis curves of the single pack have a smaller excursion than the double pack curves because of the disproportionately smaller dose reaching the epithelium. In its onset and ascent, it also occurs five days later than the double small pack curve.

A study of the curves indicates that the time of appearance of the epithelitis and epidermitis is a function of the daily dose and varies with it, rather than being a constant natural phenomenon evoked by varying doses of radiation.

Study of the Rate of Shrinkage of a Tumor

Examination of the rate of shrinkage of a tumor yields some information concerning cellulicidal effects. However, conclusions based on shrinkage curves must of necessity be general because of the difficulty of measuring the volume of irregular masses, and because of the greater difficulty of obtaining comparative estimates of the volume of a single mass as it changes shape during regression, i.e. such as occurs when a bulky mass sloughs away, leaving an ulcer which later heals. Our method is to take external measurements, calculate the volume of the mass, and then qualify the result by empirical impressions.

The rate of shrinkage of a tumor throws little light on the course of the disease. For example, in Figure 18 are recorded the percentage shrinkage curves of those lesions treated only by external irradiation with the 5 gram pack, and which attained primary regression. The heavy lines represent the lesions which were arrested for two years with external irradiation alone; the fine lines represent the lesions which regressed initially, only to recur at a later date. The two most radiosensitive tumors recurred; whereas the two slowest shrinking lesions did not recur.

An analysis of the tumor shrinkage curves of the 21 tumors treated with all techniques and which were arrested for at least two years with external irradiation alone revealed an indistinct picture.

Those lesions treated with 0.5 and 2 mm. copper filtered roentgen rays and with the small pack reached 50 per cent shrinkage in fourteen to twenty-two days, with an average of 18.5 days (see Table II). The 5 gram pack cases were more irregular (see Fig. 18), the lesion reaching 50 per cent shrinkage in sixteen to thirty-five days. This is due somewhat to the fact that this latter group of patients received their treatments with less regularity than the former group. When all the groups of cases are

Table II

Days on which the tumor reached 50% size

	0.5 mm. Cu Roentgen Rays	2 mm. Cu Roentgen Rays	Small Pack	5 Gram Pack
Day tumor reached 50% size	22	22	22	35
	22	14	21	30
	19		19	28
	15		16	23
	14		13	22
	14			18
				17
				16

considered, the day the tumor reaches 50 per cent in size in the 21 arrested cases ranges from the thirteenth to the thirty-fifth with an average of the nineteenth day.

This is too great a range to permit the practical employment of this figure. Nevertheless, we might tentatively conclude that, "For the 0.5 and 2 mm. copper filtered roentgen-ray techniques and the small pack techniques, if the lesion of a patient receiving daily treatments has not shrunk 50 per cent by the twenty-second day, it will not be arrested by external irradiation alone, and the technique of treatment should be altered."

The weakness of this postulate is indicated by the examination of the failures in the above groups. There were 37 of them, and 23 cases, or 62 per cent of these failures, reached a 50 per cent size on the twenty-second day or earlier.

Thus the shrinkage curve offers no concrete guide or prognostic index. Nevertheless, an important decision must be made around the sixteenth to the eighteenth day, whether to continue the external radiation, or to change to interstitial radiation. This decision must be made before too much external radiation has been given, thereby reducing the tissue tolerance for interstitial radiation; and the interstitial radiation must be given before the reactive processes of the healing phase increase the radioresistance of the tumor. It is more desirable to have a small dose of interstitial radiation supplement the external radiation in a tumor bed that is fairly healthy, rather than, at a later date, to produce extensive radionecrosis by interstitial radiation with a large dose in a tumor of increased radioresistance, which lies in a fibrous, avascular tumor bed.

It is impossible to make such a decision accurately on the basis of the rate of shrinkage alone. Observation of epithelitis and epidermitis will help somewhat, but clinical experience is the best guide. The decision is frequently postponed from day to day, but should surely be made before the twenty-third day.

THE TECHNIQUE OF CHART ANALYSIS

In an attempt to predict the course of the reactions under treatment and the behavior of the tumor, we devised approximately thirty empirical postulates and tested them. The following six were the only ones of some value. The number of cases in each group was too small to warrant any real importance being attached to the statements. However, this method of analysis forms the basis for further study that may prove to be of real value.

The number of plus signs after each statement, ranging from one to four, indicates the approximate accuracy of the statement.

I. EXAMINATION DURING TREATMENT.

A. Epidermitis.

If it begins on the twelfth day or earlier, one can expect the cancer to recur.

Score: 0.5 mm. Cu—6 of 6 cases
2 mm. Cu —1 of 2
5 gm. pack —3 of 3
Small pack —no cases

Value: +++

B. Epithelitis.

If it begins on the fifteenth day or later, primary shrinkage will not occur.

Score: 0.5 mm. Cu—4 of 4 cases
2 mm. Cu —2 of 3
5 gm. pack —8 of 10
Small pack —no cases

Value: ++

C. Rate of Shrinkage.

Lesions reaching 50 per cent shrinkage on or after the twenty-third day will not attain primary regression.

Score: 0.5 mm. Cu—5 of 6 cases
2 mm. Cu —6 of 6
5 gm. pack —3 of 7 (The other 4 cases not only attained primary shrinkage, but also two year arrest)
Small pack —3 of 3

Value: ++

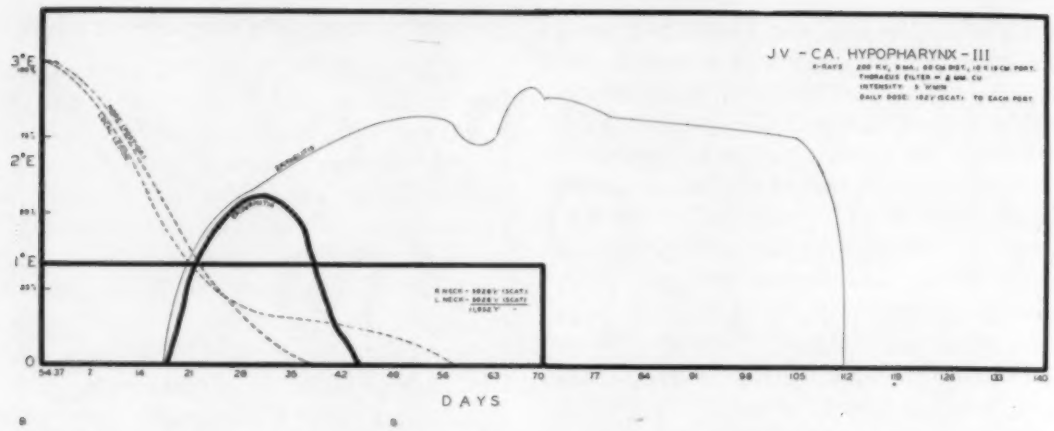

Fig. 19. Reaction chart of patient, J. V., with an extensive carcinoma of the hypopharynx running from the tonsil down to the pyriform fossa; histological Grade 3. Patient was treated with one-half the usual daily dose, i.e. 100 r to each of two portals for seventy-one days. Note that the greatest shrinkage occurred within the first three weeks due to the response of the large component of anaplastic, radiosensitive cells. This susceptibility of the anaplastic cells was consistent with the susceptibility of the normal mucosal cells, resulting in a marked epithelitis. The slow shrinkage of the residual, radioresistant, differentiated cells during the second month of treatment is consistent with the resistant epidermis which was able to heal while the treatment was being administered. Compare this graph with Figure 25, where, even in a radioresistant tumor, the greatest shrinkage still occurs during the destructive phase.

2. ANALYSIS AFTER TREATMENT.

A. Epidermitis.

If primary shrinkage has been attained, and a second degree epidermitis not reached, a recurrence may be expected.

Score: 0.5 mm. Cu—3 of 3 cases
2 mm. Cu—no cases
5 gm. pack —3 of 3
Small pack —1 of 1

Value: +++

This statement should not be confused with the fact that many cases reaching beyond a second degree epidermitis recurred (4 of 11).

B. Epithelitis.

If primary shrinkage has been attained, and a second degree epithelitis was not reached, a recurrence may be expected.

Score: 0.5 mm. Cu —2 of 2 cases
2 mm Cu —no cases
5 gm. pack —no cases
Double small pack —2 of 2
Single small pack —2 of 3

Value: +++

C. Examination of the rate of shrinkage gives some slight indication as to whether or not the cancer will recur.

Value: +++

PERIODICITY

The existence of a rhythm of radiation effect was first suggested by Coutard who integrated his observations into a phenomenon, called periodicity, wherein the skin, mucosa, and tumor each experienced specific cyclic variations in their response to protracted external irradiation. He submitted quantitative outlines of each cycle, which, however, on careful statistical analysis of his figures, are shown to have no basis in fact. Analysis of our findings indicate the existence of a totally different type of periodicity.

The bombardment of human tissues with protracted, fractionated doses of radium or roentgen rays evokes three phenomena:

1. A direct cellulicidal effect—destructive phase.
2. Healing phase.
3. Periodicity.

1. *Direct Cellulicidal Effect—Destructive Phase.* By destructive phase we refer to the period commencing with the first exposure, and extending to the time the reactions reach their peak.

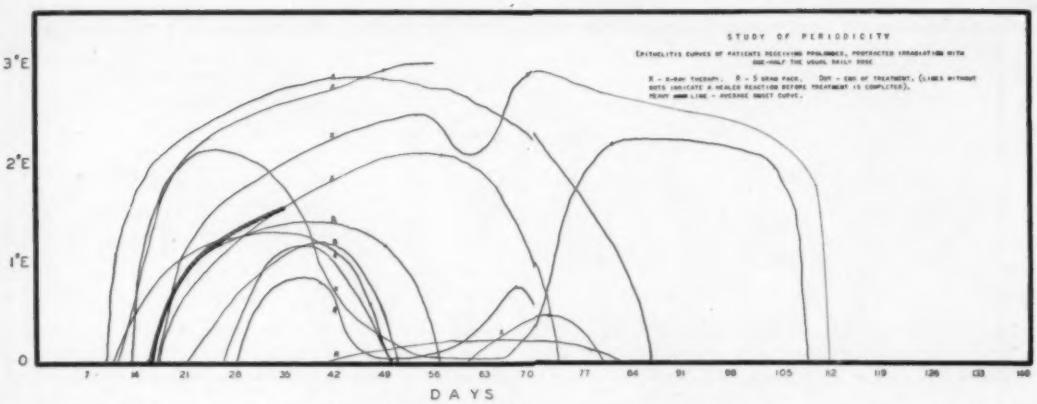

FIG. 20. Epithelitis curves of patients receiving prolonged protracted irradiation with one-half the usua daily dose outlined in Table 1 for 47 to 105 days. The heavy line running from the sixteenth to the thirty-fifth days is the average of the curves of onset of epithelitis. It is impossible to average the reactions thereafter because they vary enormously. Note that on or about the thirty-fifth day many of the reactions started to heal. One exceptional reaction commenced to heal on the twenty-sixth day. The earliest onset of the second cycle occurred around the fifty-third day.

The direct cellulicidal effect is most active during the early destructive phase of the treatment period, occupying the first seventeen to twenty-one days of treatment. In this period the immature cells of the tumor are destroyed, and the greatest amount of shrinkage is obtained, somewhat irrespective of the daily and total dose.

Thus where the daily dose is one-half our usual amount, namely, 100 r (scattered) to each of two portals, and the tumor is sensitive (see Fig. 19), there is a rapid early shrinkage of the tumor, it reaching 50 per cent in size on the seventeenth day. Where our usual daily dose is employed and the tumor is radioresistant (Fig. 25), the greatest shrinkage still occurs during the first three weeks.

Thereafter, the rate of shrinkage is retarded. This is probably due to the fact that the remaining tumor is composed of radioresistant adult cells. On the basis of similar observations, there has been recommended the "ascending dose technique" whereby the daily dose is small at first, but with a progressively increasing increment. The purpose is to avoid overtaxing the skin. However, this hypothesis neglects three factors: (1) adult cells also shrink most rapidly in the first seventeen to twenty-one days; (2) at the time when the dose is being increased, the body has commenced to defend itself against the destructive radiation by a rapid acceleration of the healing process, and (3) the large number of hypersusceptible individuals would prevent the administration of sufficient radiation in the latter part of the treatment. The same criticism might be directed at the idea of a "preliminary preparation period" during which time small doses of radiation are given in order to prepare the tumor for subsequent treatment.

The exact limits of the destructive phase are rather difficult to define as they depend upon many controllable and uncontrollable factors, such as: (1) the size of the daily dose; (2) individual susceptibility; (3) the quality of the radiation; (4) the daily exposure time; (5) the frequency of the treatment.

(1) *The Size of the Daily Dose.* If the daily dose is high the reactions will appear early, and will be intense and prolonged. If the daily dose is small, the reactions appear late, are very mild, and heal early. This is borne out by the examination of the epithelitis and epidermitis curves (Figs. 20 and 21) of those patients treated with one-half the usual daily dose (i.e. 100 r to each of two portals; or 2,500 mg-hr. to only one portal, or a double 50 mg. pack).*

* These average curves are not very accurate because of the paucity of cases and the wide dispersion of the curves. Neverthe-

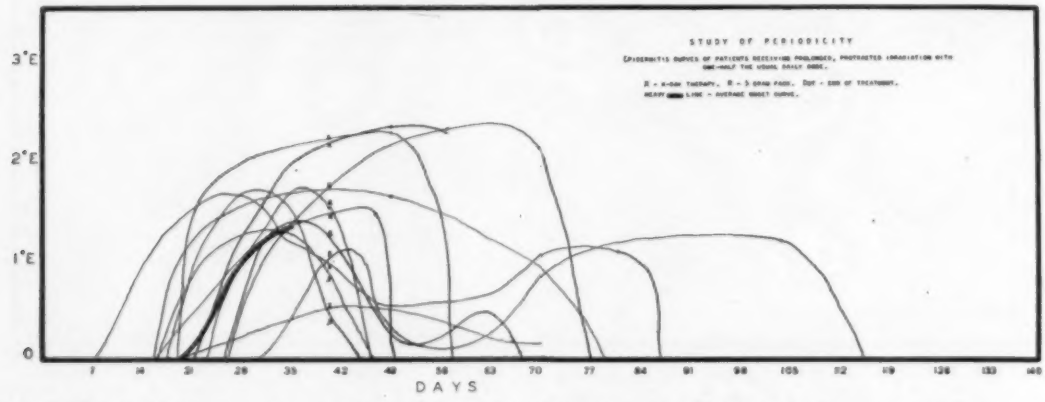

FIG. 21. Epidermitis curves, companion to the epithelitis curves in Figure 21. The heavy line represents the average onset of reaction curve. Note the large number of reactions which commenced to heal about the thirty-fifth day; and that the earliest day for the onset of the second cycle was the fifty-third day.

In Figure 22, the average reaction curves of the patients treated with one-half the usual daily dose are compared with similar curves of patients treated with the usual daily dose. From this, it can be seen that the smaller the daily dose is, the later is the time of onset of the reactions, the slower is their rate of ascendency, and the lower is their intensity.

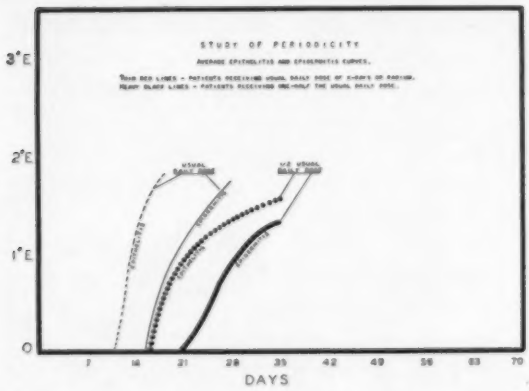

FIG. 22. Average onset of reaction curves. The fine lines represent the average curves of patients treated with the usual daily dose and were transposed from Figure 6. These heavy lines represent the average onset of reaction curves of patients treated with one-half the usual daily dose and were transposed from Figures 20 and 21. The dotted lines represent the epithelitis, the solid lines the epidermitis. Note that, during the destructive phase, the onset and ascent of the reactions is dependent upon the size of the daily dose. The smaller the dose, the later do the reactions appear. This same conclusion can be drawn from curves in Figure 17.

Further evidence that the destructive phase is dependent upon the daily dose is observed when comparing the single and double small 100 mg. pack (see Fig. 17). The average epithelitis produced by the double pack began on the ninth day, whereas the average epithelitis produced by the single pack, which transmits a smaller dose to the mucosa, began on the seventeenth day.

(2) *Individual Susceptibility.* A patient may be given our usual daily dose or one-half that dose, and yet develop reactions which are early, intense, and prolonged. Thus T. F. (Fig. 23), was treated at the rate of 100 r to two portals daily and received a total dose of 8,200 r in forty-nine days. Yet his epithelitis commenced on the tenth day, reached almost a third degree intensity and lasted seventy-four days; and his epidermitis also was much more intense than expected. His reactions were similar to those ordinarily expected when high daily doses are employed, such as 300 or 400 r to each of two portals and a total dose of 8,000 r given in ten days. Though this patient's skin and mucosa were hypersusceptible to roentgen rays, his tumor (epidermoid carcinoma of the posterior oropharynx) was not. It behaved in an

less, they indicate a central tendency. The average is computed only up to the thirty-fifth day because at that time many of the reactions commence to heal; one epithelitis reaction commenced to heal even earlier than that.

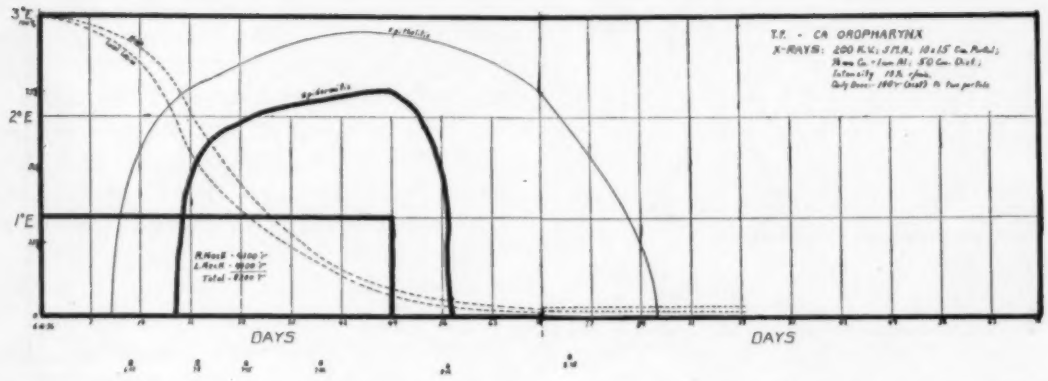

Fig. 23. Reaction curves of a hypersusceptible patient, T. F., who had a carcinoma of the posterior oropharynx. The patient is markedly hypersusceptible, and though his daily dose to each portal was only 100 r, he reacted as though it were thrice that. Though his skin and mucosa were hypersusceptible, his tumor was somewhat hyposusceptible. This demonstrates the difficulty in attempting to utilize the pattern of the skin and mucosal reactions to express the behavior of the tumor.

average fashion, shrinking like a moderately radioresistant tumor, reaching 50 per cent size on the twenty-third day, and then regressing slowly, and never disappearing completely.

The other extreme is the case of W. W. (Fig. 24), whose daily dose to each of two portals was 204 r for the first fourteen days, 340 r for six days and then 408 r for the last ten days. The total dose was 11,300 r delivered in thirty days. In spite of these high daily doses the epithelitis was less than a first degree intensity (dryness), and the epidermitis reached only a first degree intensity commencing tardily on the twenty-second day, and subsiding completely on the forty-seventh day. These reactions resemble the ones ordinarily expected with a daily dose of half the average intensity. The patient's skin and mucosa were hyposusceptible, and the tumor (epidermoid carcinoma of tonsil and tongue) acted in a similar fashion, shrinking 50 per cent in sixteen days and 90 per cent in forty-nine days.

Thus, the extent and duration of the destructive phase is dependent upon individual idiosyncrasy. That unusual reactions are not infrequent may be deduced from the fact that, in a group of 126 cases of our series, 4 radium and 5 roentgen-ray patients were markedly hyposusceptible; and 4 radium and 18 roentgen-ray patients were markedly hypersusceptible. To summarize, 24 per cent of the patients exhibited unusual reactions. Idiosyncrasy has been assumed to be a rare phenomenon, but actually there exists a somewhat regular distribution of individual susceptibilities throughout a wide range, congregating to a slight extent around a medial central tendency.

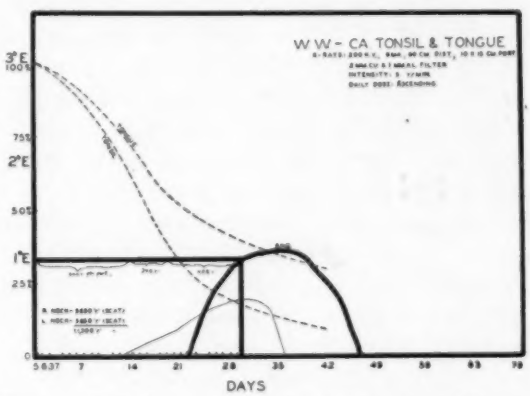

Fig. 24. Reaction curves of a hyposusceptible patient, W. W., who had an extensive carcinoma of the tonsil with extension into the tongue, histological Grade 3. He received large daily doses, ranging from 204 r to each of two portals up to 408 r. Nevertheless his reactions were late in onset and mild in character. Histologically, this tumor was very similar to the one in Figure 19, and it responded similarly, though the treatment and the reactions differed considerably. The 3 cases in Figures 19, 23 and 24 demonstrate that the destructive phase is dependent, in addition to other things, upon the susceptibility of the patient.

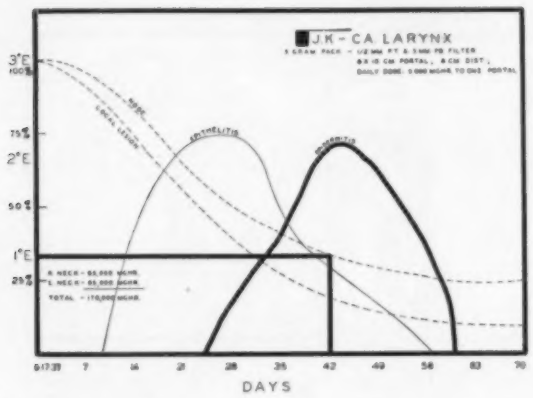

Fig. 25. Reaction curves of patient, J. K., carcinoma of the larynx. He was treated with the 5 gram pack receiving the usual daily dose of 5,000 mg-hr. to one portal daily. His tumor was radioresistant and by the twenty-eighth day, when he received the contemplated total dose of 120,000 mg-hr., it had not shrunken satisfactorily. Since he demonstrated a strong healing tendency, as was evidenced by an early healing of the epithelitis and a late onset and slow ascent of the epidermitis, it was felt that further therapy could be given, without undue reactions. The tumor regressed still further. This indicates the type of therapeutic deductions which can be based upon the pattern of the reactions.

The above illustrations further indicate that the response of the tumor is somewhat independent of the susceptibility of the patient's skin. Thus the patients in Figures 19 and 21 each had squamous cell epidermoid carcinoma, Grade 3 (Broders' classification). They received the same total doses, but in one case it was given at the rate of 100 r daily to each of two portals for seventy days, and in the other instance at the rate of 200 to 400 r daily to each of two portals for thirty days. Nevertheless the rate of regression of the tumors was approximately the same. Thus an attempt to base laws of tumor responses on the basis of skin and mucosal reactions alone is apt to be misleading.

(3) *The Quality of Irradiation.* This has been demonstrated previously in Figures 6 and 13.

(4) *The Daily Exposure Time.* See section on small pack.

(5) *The Frequency of the Treatment.* Interruptions in the regular treatment not only weaken the effect of the dose, but also result in greater individual variations. Analysis of the reaction curves of those patients who missed two or more treatments a week revealed that the reactions started later, were less intense and exhibited a wider range of individual variation. This is probably due to the fact that the recovery factor was permitted to acquire additional momentum by virtue of the extra rest periods, and also to the fact that, when treatments are missed, the treatment period extends into the healing phase, where individual variations are magnified (Fig. 7).

2. *Healing Phase.* In protracted fractionated irradiation, the destructive force is cumulative. Its effect starts slowly, being first manifested after a lag of seven to fourteen days, at which time the reactions commence. The effect then accelerates at varying rates depending upon the factors discussed above. The production of destructive effects upon tissue by irradiation evokes reactive or healing processes. These latter are slower in starting than the former but soon accelerate in power so that the healing processes finally overwhelm the destructive processes and initiate the healing phase. In Figure 26, the healing phase in the skin commences on the twenty-sixth day, and in the mucosa on the twenty-sixth day.

The limits of the healing phase are more difficult to define than those of the destructive phase. They commence by definition, at the peak of the reactions and continue for varying intervals, depending upon the criterion used for their termination. This may be either the point when the reactions finally heal, or the time when the tumor ceases to regress, or the time when reparative fibrosis ceases to function actively or the time when the second destructive phase commences.

Though the destructive phase is somewhat irregular in duration and intensity, the healing phase is much more so.

A picture of the delicate mechanism of the healing phase can only be obtained when the reactions are mild, as a consequence of small daily doses, or when an

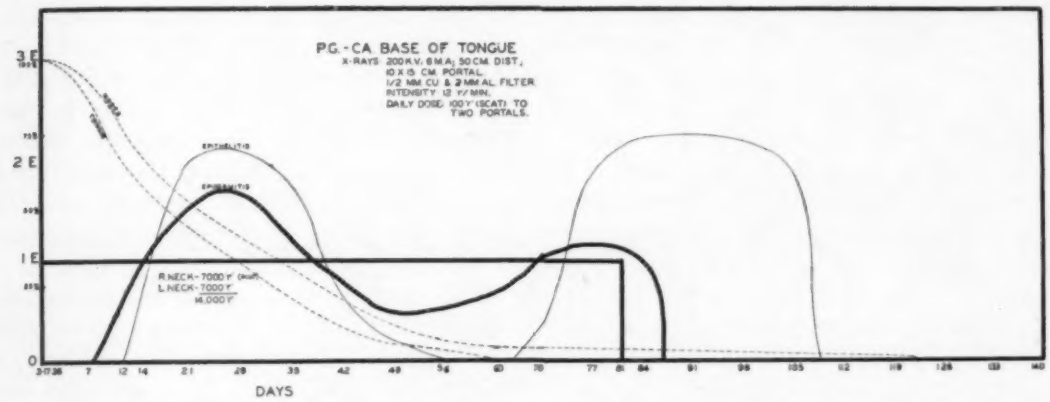
P.G.-CA BASE OF TONGUE
X-RAYS 200 K.V. 6 M.A. 50 CM. DIST.
10 X 15 CM. PORTAL
1/2 MM. CU & 2 MM. AL. FILTER
INTENSITY 13 R/MIN.
DAILY DOSE 100 R (SCAT.) TO TWO PORTALS.
3 E
2 E
1 E
0
DAYS

Fig. 26. Reaction curves of patient, P. G., who had an anaplastic carcinoma of the base of the tongue, and who was treated with one-half the usual dose for eighty-one days. It is the best illustration of the type of periodicity we observed. The clearly defined healing phase lasted from the twenty-sixth to the fifty-sixth day. Note again that the greatest destruction of the tumor occurred within the first three weeks. This patient was not radio-immune as was the patient in Figure 24, because his reactions started on time. Yet the recovery or healing factor, which started slowly, soon gathered momentum and gained ascendency over the destructive force, thus initiating the healing phase.

individual is hyposensitive. If the incident dose is large, or the patient is hypersensitive, the reactions are intense, producing massive, unselective destruction which is not repaired but crudely replaced by fibrous tissue. If the incident dose is small, the reactions commence at a later date and ascend more slowly, and are of a lesser degree. It is this low daily dose (100 r roentgen rays to each of two portals, or 2,500 mg-hr. with the large pack to one portal), which is subintensive enough to permit delicate biological phenomena such as cyclic effects to manifest themselves.

We do not know whether a strong healing tendency is the same as radio-immunization. They may both induce similar reactions, i.e. patient W. W. (Fig. 24) received large daily (200–400 r per portal) and total doses (11,300 r) but sustained small reactions which occurred late. Skin and mucosa were immunized against radiation effect. However, in those patients treated with one-half the usual daily dose, some of the reactions started and ascended on time, indicating that the patient was not radio-immune during the destructive phase; yet these same reactions healed while the treatments were still being given, by virtue of the fact that the healing process or the recovery factor, or the adaptation factor (Ewing's term), gained ascendency over the destructive process (Figs. 26 and 29).

In our cases receiving one-half the usual daily dose, and developing reactions which were not severe, the healing phase of the epithelitis commenced between the twenty-sixth and the forty-second days (Fig. 20). The healing phase of the epidermitis reactions ranged between the twenty-sixth and the forty-fifth days (Fig. 21). In patients receiving the usual daily dose of 200 r to two portals, or 5,000 mg-hr. to one portal, but whose reactions were mild and healed while treatments were being given due to a primary radio-immunization, the healing phase commenced between the twenty-eighth and forty-second days.

Thus on the basis of a relatively small number of cases, the healing phase of the most typical cases commenced approximately between the thirty-fifth and the forty-second days.

The healing phase is dependent upon: (1) the size of the dose; (2) individual susceptibility; (3) the quality of the radiation.

(1) *The Size of the Dose.* The skin erythema dose is the smallest dose whose reactions can be observed. Its destructive phase is short, terminating at the peak of the erythema, at which time the healing

phase commences. Thus the healing phase of this small dose would commence approximately at the fourteenth to sixteenth day. If a larger single dose than this is given, or if the patient is hypersusceptible, the healing phase naturally commences at a much later date, after the force of the more intensive destructive effect has been fully expended. This point may occur anywhere from the sixteenth to the sixtieth day. When an average course of protracted external irradiation is given, i.e. 8,000 r or 120,000 mg-hr. in twenty-one to twenty-eight days, the healing phase commences anywhere from the twenty-sixth to the forty-second day, this being the point when the reactions commence to subside.

In general, the healing phase for the skin commences one week later than that of the mucosa.

Arbitrarily speaking, when the dose administered is large and produces a severe destructive effect, the reactions tend to be constant (see Figs. 2 and 3). However, when the dose is subintensive and the capacity of the body to react against it is not overwhelmed, a wide variety in the intensity of the reactions appears, depending upon the capability of the patient's healing processes to repress the destructive phase.

(2) *Individual Susceptibility*. This is self evident as indicated above.

(3) *The Quality of the Radiation*. We have not yet been able to secure sufficient evidence on this point. It is our impression (see Figs. 20 and 21) that in protracted irradiation with subintensive doses which produce mild reactions, the healing phase, is independent of ray quality, because, during the healing phase, the individual variations are so enormous as to obscure the minor ray quality differential effects. It is possible that the observed difference in the time of onset of the erythema from a single skin erythema dose, when comparing roentgen and gamma rays, is dependent not only upon the destructive factor but also upon the healing or recovery factor.

3. *Periodicity*. During the administration of prolonged, protracted irradiation, wherein the destructive force is maintained at a subintensive level, either actively by the use of a small daily dose, or passively by the counteraction of a strong healing tendency, the gradually cumulating healing force is converted from a potential to a kinetic energy and finally overwhelms the destructive force. This initiates the second, or healing phase of the cycle (Fig. 26).

The average healing phase commences between the thirty-fifth to the forty-second day, though it may commence as early as the twenty-sixth day, or later than the forty-second day. It usually lasts four to eight weeks until the healing force has spent its energy, and the destructive force once again predominates.

The repetition of the cycle constitutes periodicity. In our cases, the fifty-third day was the earliest day for the onset of the second cycle (Figs. 20, 21, 26, 27 and 30). It is our impression, therefore, that periodicity is not a cyclic alternation of cellulicidal effects, occurring as a function of the destructive force, but a shifting of the balance of power between the destructive and healing processes.

When the daily dose is large, radiation factors determine the reactions which are severe, and there is a certain degree of constancy of the reactions. When the daily dose is small and protracted for an unusually long time, or when the tissues are hyposusceptible, the healing phase predominates and determines the nature of the reactions, which show a wide range of variations. Figures 26 and 27 are typical examples.

In patients receiving prolonged protracted irradiation with small daily doses, it is observed that the greatest amount of shrinkage of the tumor occurs during the first three or four weeks of treatment, regardless of the type of cell. During the healing phase there is very little shrinkage, and there may even be a recurrence of the tumor if the cell is sufficiently adult to be able to adapt itself to radiation bombardment (Fig. 28).

During the second cycle of reactions the amount of shrinkage is proportionately

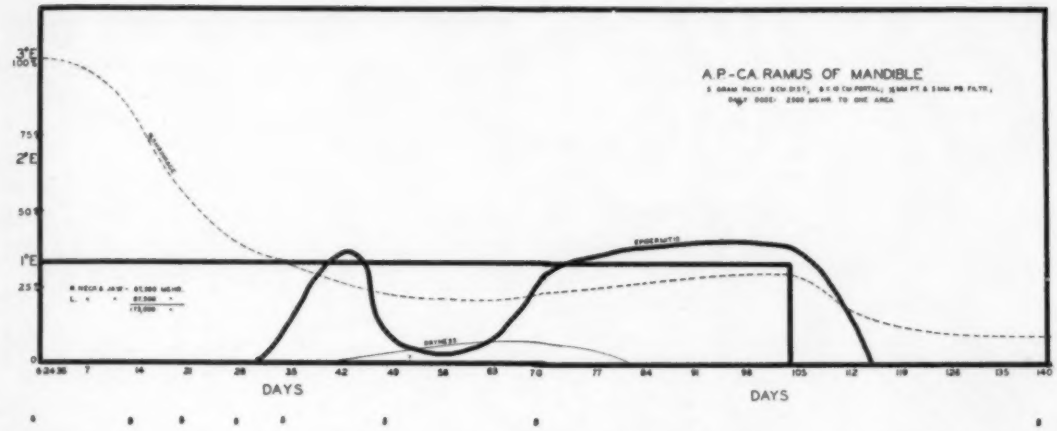

FIG. 27. Reaction curves of A. P., carcinoma of the ramus of the mandible, treated with one-half the usual dose of gamma rays. Note the great variation between these curves and those of Figure 26. Note also that the greatest destructive effect occurs in the first three weeks. Note finally that during the healing phase, when the lesion started to recur, this growth impetus together with the increased radioresistance of the tumor rendered the second destructive phase much less effective than the first, so that only toward the end of the second destructive phase did any growth inhibition manifest itself. Incidentally, the tumor finally recurred and grew beyond control on the 175th day.

smaller than during the first cycle (Fig. 27) This is to be expected, and confirms the fact that radiation therapy is most effective during the first three or four weeks of treatment. When feasible, the greatest amount of radiation should be administered during this time, regardless of any hypothetical theories of periodic cellulicidal effects or observed cycles of reactions as demonstrated above.

The administration of one-half the usual daily dose is an experimental technique, and an inferior one. Even in those cases where there was a rapid early shrinkage (Fig. 19) the residuum was more difficult than usual to eradicate because it had matured morphologically and biologically.

It is our empirical impression, based on the observation that periodic effects first present themselves during the healing phase which commences shortly after the twenty-eighth day, that the phenomenon of periodicity is a function of the healing processes. When it is applied to cancer cells, consideration must be given to their differentiation and capacity to heal.

SUGGESTED PLAN OF TREATMENT

The best plan is to administer all treatment before the healing phase commences, i.e. twenty-eighth to forty-second day, with an average of the thirty-fifth day. Radiation administered during the healing phase is probably wasted (Fig. 31). The most effective treatment in our series was the administration of 7,742 to 8,160 r given

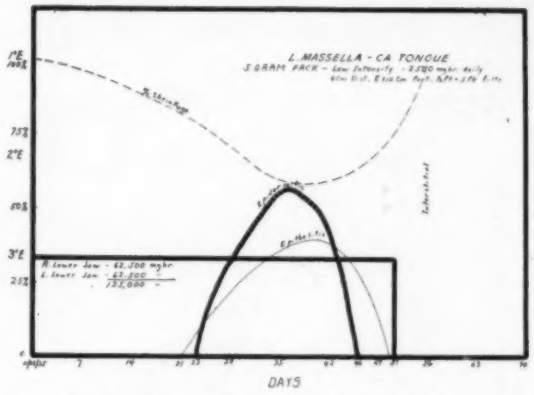

FIG. 28. Reaction curves of patient, L. M., with carcinoma of the tongue of low grade malignancy and treated with one-half the usual daily dose of gamma rays. The patient presents a consistent picture throughout. His strong healing or adaptation factor rendered him somewhat radio-immune, as was manifested by tardy reactions of a mild character, which healed early. His tumor, which was initially radioresistant, also was endowed with a strong recovery or healing factor, and soon adapted itself to the gamma-ray bombardment so as to proliferate and increase in size during the healing phase, while treatments were being given.

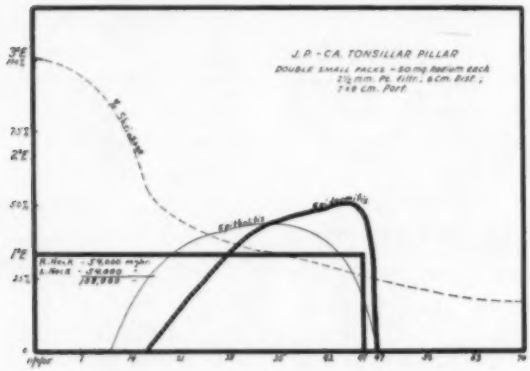

FIG. 29. Reaction curves of patient, J. P., with an extensive carcinoma of the tonsillar pillar treated with one-half the usual daily dose by means of double small 50 mg. packs. The percentage shrinkage curves illustrate the sharp contrast between the marked effectiveness of radiation during the destructive phase, and the slight effectiveness during the healing phase.

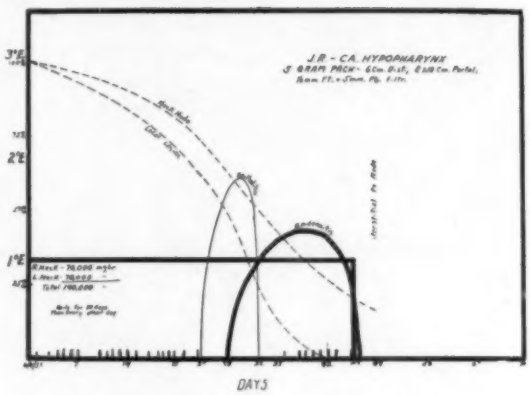

FIG. 31. Reaction curves of patient, J. R., with a carcinoma of the hypopharynx treated with the usual daily dose of gamma rays. After the twenty-fifth day, the patient failed to return for treatments for eleven days. This permitted the healing process to gain such headway that treatments given from the thirty-sixth to the forty-fifth days had no effect upon the reactions. It would have been wise to allow thirty days instead of eleven days for the healing process to be dissipated before administering the second course of treatments. The small perpendicular lines along the baseline indicate the days on which treatments were given.

in twenty-two or twenty-five days. Four lesions of four so treated were arrested for at least two years. This statement does not intend to imply that this is the best way to treat all tumors of the upper respiratory tract.

In those instances where it is believed that the usual course of protracted external irradiation will not eradicate the disease, because the tumor is either radioresistant or advanced, we have outlined a technique based upon our observations and interpretations of periodicity. The major premise is to avoid any radiation during the healing phase which commences approximately between the twenty-eighth and the forty-

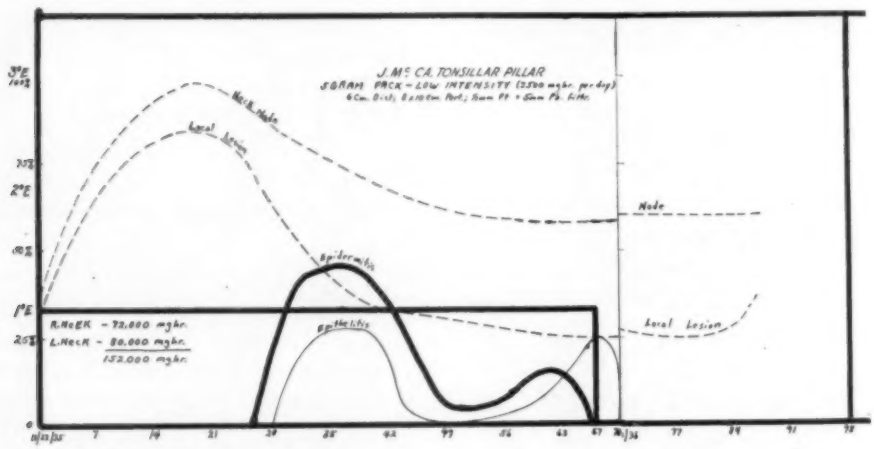

FIG. 30. Reaction curves of patient, J. McK., with a very extensive carcinoma of the tonsillar pillar rendering the patient moribund. Radiation with one-half the usual daily dose was started a few days following resection of part of the mass in order to reopen the oropharynx, hence the initial impetus toward rapid growth of the tumor during the first eighteen days. Note the observed periodicity of the reactions.

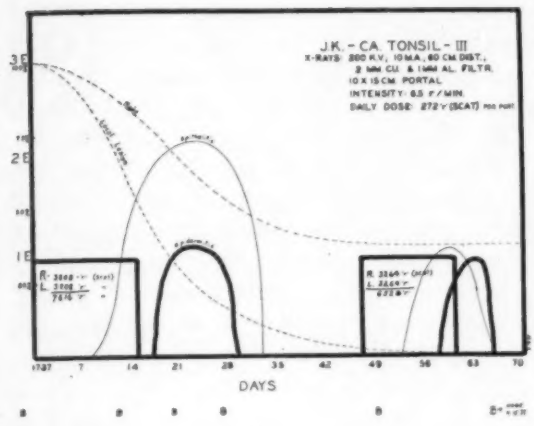

Fig. 32. Reaction curves of patient, J. K., with a radiosensitive carcinoma of the tonsil, histological Grade 3. The lesion and metastatic nodes were so extensive as to render the prognosis grave if the usual technique of continuous treatment was employed. The treatment was planned therefore as indicated above in order to avoid giving any radiation during the healing phase. Since a radiosensitive tumor is probably chiefly affected by the cellulicidal effects of the rays, the unit dose was increased in order to contract the treatment period within the confines of the destructive phase. The total dose was calculated to produce subintensive threshhold second degree reactions, so as not to prevent the administration of an effective second course of treatments. The patient is well (9/15/39).

second day and lasts for four to six weeks. If the tumor is radiosensitive use a high daily dose (i.e. 275 r to each of two portals), and give a short course of treatments, lasting fourteen to sixteen days (Fig. 32). The total dose should be slightly less than our usual dose of 8,000 r. Keep the reactions at the level of or below a second degree intensity. Wait one month for the healing phase to pass off, and repeat with a somewhat smaller dose. If the lesion is radioresistant, use a smaller daily dose for a longer period of time, then wait for five or six weeks, and repeat the course (Fig. 33). These suggestions are as yet purely speculative.

The principle of avoidance of any treatment during the healing phase is probably important in the treatment of carcinoma of the breast and cervix, where the daily cumulative dose to the skin and tumor is low and where the healing phase and recovery factor consequently play a correspondingly more important rôle.

SUMMARY AND CONCLUSIONS

1. When comparing clinical effects of 200 kv. roentgen rays filtered with 0.5 and 2 mm. copper, it is found that the shorter

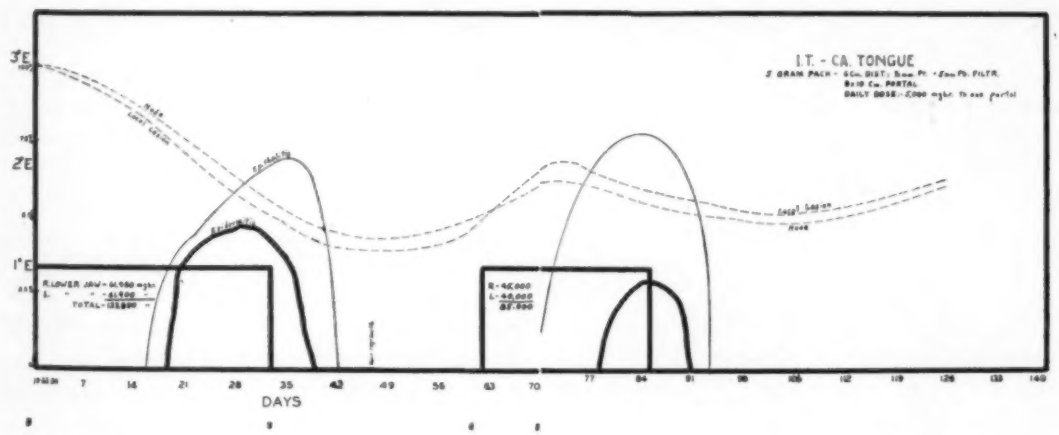

Fig. 33. Reaction curves of patient, I. T., with a radioresistant carcinoma of the tongue, histological Grade 1. The procedure of treatment was based upon the same principles as in Figure 32, except that the unit dose was not higher than usual, and was extended throughout the entire destructive phase. The second course of treatment accomplished little. It was felt that if the treatment had been carried on through the healing phase, the tumor would have adapted itself to the radiation, and the second course might not have retarded the growth at all, as occurred in Figure 28.

the wave length, the less biologically effective is the roentgen as far as the skin and mucosal reactions are concerned. This is consistent with the fact that radiations of shorter wave length require a larger number of roentgens for an erythema dose. The respective epithelitis and epidermitis produced by the rays of shorter wave length appear later and reach a second degree intensity later than those of the longer wave length. No difference in effect on the tumor between the above two wave lengths has as yet been demonstrated.

2. During the destructive phase of the reactions, occupying approximately the first four weeks of the treatment, the reactions increase in intensity and vary somewhat for the individual case. If the dose and rate of administration are the same, the reactions vary ± 3 days in their onset and ascent. During the healing phase, the individual variation is enormous, being as much as ± 20 days.

3. When protracted fractionated irradiation is given with gamma rays, the onset and ascent of the epithelitis and epidermitis occur at approximately the same time as the 200 kv. roentgen-ray reactions. A possible explanation is that protracted fractionated irradiation constitutes such an intense effect that the destructive phase (with its tendency toward constancy) dominates the picture and overwhelms the more delicate biological phenomena observed when a comparison is made using subintensive doses, such as a single skin erythema dose.

4. When the dose of gamma and of roentgen rays is such as to produce equivalent skin effects (epidermitis), it is found that the epithelitis (representing the effect of the absorbed radiation in the depth) produced by roentgen rays is more intense than that produced by gamma rays. This is probably due chiefly to the difference in depth dose. For the same reason, roentgen rays produce epithelitis reactions of a greater magnitude than epidermitis reactions, whereas gamma-ray epithelitis is the same or lesser magnitude than epidermitis.

5. It is our impression based upon a small number of cases that continuous irradiation with small radium packs is the most effective type of external irradiation.

6. When comparing the effects of twenty-four-hour-a-day with one-hour-a-day exposure time, it is observed that the former technique requires only 80 per cent of an arbitrary total dose as compared with 100 per cent of an arbitrary dose required by the latter to produce the same biological effects. In other words, twenty-four-hour-a-day exposure time is 20 per cent more effective than one-hour-a-day exposure time.

7. Though examination of the rate of shrinkage of a tumor under treatment yields little information concerning the course of the disease, nevertheless some practical use can be made of the "day" the tumor reaches one-half its original size. If the tumor has not shrunk 50 per cent in size by the twenty-second day, it will most likely not be destroyed by external irradiation alone, and the treatment should be changed to avoid unnecessary and ineffectual external irradiation. If possible, the decision should preferably be made by the eighteenth or nineteenth day, using other factors such as the behavior of the skin and mucosa for the purpose of prognostication.

8. A technique for chart analysis is outlined whereby the possible behavior of the tumor can be predicted during treatment, and immediately after treatment.

9. The existence of recurring cycles of increased cellulicidal effects at thirteen day intervals, has not been proved. We have observed a type of periodicity, which seems to result from an alternation of the destructive process with the healing process.

10. The destructive phase occupies the first four to six weeks of protracted irradiation. At this time cellulicidal effects predominate. During the first destructive phase, the cellulicidal action of the rays is more potent that at any future time. The destructive phase varies somewhat in its intensity and duration, being dependent

upon the size of the daily dose, individual susceptibility, the quality of the radiation, the daily exposure time, and the frequency of the treatment.

11. The healing process commences as a more or less immediate response to the first dose of roentgen rays. It is slow to start, but soon gathers increasing momentum so as to finally overwhelm the destructive effects of the daily doses, thus initiating the healing phase. The healing phase commences between the twenty-eighth and the forty-second day. During this period, if the dose is not too great or the patient too hypersusceptible, the epithelitis and epidermitis may heal, and the more differentiated tumor cells become resistant to or impervious to the destructive effects of the rays. The healing phase varies enormously in intensity and duration with different individuals.

12. After an average period of four to eight weeks the healing force is dissipated and the destructive force once again predominates. *The repetition of the cycle constitutes periodicity.* During the second destructive phase the cellulicidal effect on the tumor is much weaker than during the first.

13. Methods are suggested whereby practical use may be made of the principles of periodicity. These methods are speculative and their value is still to be demonstrated.

The authors wish to express their gratitude to Dr. Ira I. Kaplan, Director of the department, for his cooperation in providing the means and material for this work, and for his many helpful suggestions and guidance. They also thank Mr. Carl B. Braestrup for his collaboration in supervising the physics of radiation dosage and for his help in the conduct of the work and the preparation of the paper. The authors also gratefully express their thanks to Mr. Wallace Bloom for his assistance in the statistical analyses, and for his many other original and helpful suggestions.

APPENDIX

Averages. The existence of a wide range of individual variations of radiation reactions renders it difficult to obtain an average reaction curve. The average is statistically defined as a measure of the location of the central tendency. However, in order to insure that the average curves herein employed represent not only the central tendency, but also indicate the influence or pull exerted on the central tendency by the less typical reactions, three types of averages were employed: the arithmetic mean, the median, and the mode. The arithmetic mean of these three averages was then finally used as the basis for the average curves in the charts.

For example, the average curve of onset of the epithelitis in Figure 2 was obtained by taking the arithmetic mean, median, and mode of seven different points along the curve. Then the arithmetic mean of these three averages was employed to express each point on the final reaction curve.

Table III represents the frequency distribution of two such points (day of onset, and day it reached the second degree) of the epithelitis and epidermitis of the 0.5 mm. copper roentgen-ray curves. Table IV represents the same factors of the 2 mm. copper roentgen-ray curves. Table V presents the respective averages of columns C, D, E, F, in Table III and columns I, J, K, L, in Table IV. As a more specific illustration, column C in Table III will be utilized.

The *Arithmetic Mean* is a calculated average and is obtained by adding all the items together and dividing the total by the number of items used. Thus the arithmetic mean of column C is 9.38.

The *Median* is an average of position and is the value of the middle item when they are arranged according to size. The median more accurately represents the central tendency because it is not affected by extreme or unusual items. The arrangement of the items in column C is as follows:

6 6 7 8 8 9 9 10 10 11 11 13 14

Of these thirteen items, 9 is the seventh or middle item, and hence constitutes the median.

The *Mode* is the most frequent or most common value, provided that a sufficiently large number of items are available to give a smooth distribution (column C is rather weak is this respect). It is entirely independent of extreme or unusual values, but does reflect the influence or pull of the off-center values.

$$\text{Mode} = L_{mo} + \frac{f_a}{f_a + f_b} C$$

TABLE III

TABULATION OF INDIVIDUAL 0.5 MM. COPPER REACTION CURVES

Total r at end of		Epithelitis		Epidermitis	
10th day	17th day	Day of Onset	Day it Reached Second Degree	Day of Onset	Day it Reached Second Degree
1600	2800	7	17	14	25
1600	2800	8	17	15	—
1600	2800	11	16	17	—
1800	2800	8	14	7	24
1800	3000	6	1.9 at 26 D.	12	—
1800	3000	6	15	6	27
1800	3000	9	14	13	25
1800	3000	9	14	11	31
1800	3000	10	15	18	—
1800	3000	10	16	20	35
1800	3000	11	17	15	32
1800	3000	13	21	19	—
1800	3000	14	19	14	—
A	B	C	D	E	F

TABLE IV

TABULATION OF INDIVIDUAL 2 MM. COPPER REACTION CURVES

Total r at end of		Epithelitis		Epidermitis	
10th Day	17th Day	Day of Onset	Day It Reached Second Degree	Day of Onset	Day It Reached Second Degree
1600	2800	16	—	12	—
1600	2800	14	27	22	33
1800	2800	13	28	17	22
1800	3000	18	—	22	—
1800	3000	17	25	28	42
1800	3000	16	26	19	30
1800	3000	14	—	17	—
1800	3000	13	18	15	23
1800	3000	12	16	15	—
1800	3000	10	19	14	28
1800	3000	10	—	13	—
1800	3000	10	—	19	—
1800	3000	8	19	14	35
1800	3000	7	17	11	—
1800	3000	6	19	14	33
1800	3000	5	17	12	27
G	H	I	J	K	L

where

L_{mo} = lower limit of modal group

f_a = frequency of class interval above modal group

f_b = frequency of class interval below modal group

C = size of class interval

Thus the mode for column C would be:

$$\text{Mode} = 8 + \frac{3}{3+3} \cdot 3 = 9.5$$

TABLE V

DIFFERENT TYPES OF AVERAGES, RANGE, AND MEAN DEVIATION OF THE COLUMNS OF FIGURES IN TABLES II AND III. THESE WERE THE FINAL POINTS USED TO CONSTRUCT THE AVERAGE CURVES

	Epithelitis				Epidermitis			
	Day of Onset		Day it Reached Second Degree		Day of Onset		Day It Reached Second Degree	
	0.5 mm. Cu	2 mm. Cu	0.5 mm. Cu	2 mm. Cu	0.5 mm. Cu	2 mm. Cu	0.5 mm. Cu	2 mm. Cu
Arithmetic mean	9.38	11.8	16.2	21	13.9	16.5	28.4	33
Median	9.0	11.0	16.0	19	14	15	27	30
Mode	9.5	12.5	16.2	20.5	14.5	16.3	—	33.3
Range of days	6–14	5–16	14–21	16–28	6–20	11–28	24–35	22–42
Mean deviation	1.9	3.4	1.7	4.2	3.1	3.5	Large	Large
	C	I	D	J	E	K	F	L

where the modal group has a class interval of 3 and contains the items, 8, 8, 9, 9, 10, 10.

The above averages may have varying significance depending upon the range of individual variations. If the individual variations are great and there is a diffuse distribution of the items such as in column C, then the average curve has only a moderate significance. A more ideal hypothetical distribution of these items would have been the following:

6 8 8 9 9 9 9 9 9 10 10 13 14

From this hypothetical distribution it can be seen that the modal or most common group is a large one, and that atypical items congregate in the greatest numbers on either side of the modal group. Some method should therefore be provided for expressing this favorable distribution and the relative accuracy of its average figure. This can be done by means of the range, the mean deviation, and the standard deviation see Table V.

The *Range* is the difference between the largest and smallest items in the series. The range of column C is the same as in the above hypothetical series of figures and yet the character of the two groups differs markedly. The range obviously does not provide a good indication as to the character of the dispersion and its averages, because it depends exclusively on its two extremes.

The *Mean Deviation* provides a better picture of the character of the dispersion. It is the average of the differences between the mean (or median) and each item in a series, ignoring the signs.

For example, the items in column C are:

6 6 7 8 8 9 9 10 10 11 11 13 14

The median is 9. The tabulated list of the differences between the median, 9, and each item (ignoring the plus or minus signs), is:

3 3 2 1 1 0 0 1 1 2 2 4 5

The average of this list is 1.9. Hence the mean deviation of column C is 1.9.

The *Standard Deviation* is much more complicated and was not employed in our calculations. It is the root-mean-square of the deviation from the arithmetic mean.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Forty-first Annual Meeting: Boston, Mass., 1940.

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Committee on Arrangements: Douglas Quick, Chairman, New York City, Maurice Lenz, New York City, Hayes E. Martin, New York City.

Representatives on American Board of Radiology: Douglas Quick, New York City, R. H. Stevens, Detroit, Mich., B. P. Widmann, Philadelphia, Pa.

Delegates to the Sixth International Congress of Radiology: Albert Soiland, Los Angeles, Calif., Delegate, Zoe A. Johnston, Pittsburgh, Pa., Alternate Delegate.

Twenty-fifth Annual Meeting: New York City, 1940.

EDITORIAL

THE ANNUAL MEETING

THE Fortieth Annual Meeting of the American Roentgen Ray Society held at the Palmer House, in Chicago, Illinois, on September 19 to 22, 1939, reached a high water mark as regards the quality and character of the meeting as well as the attendance, over eight hundred being registered. This great increase in registration was due to many things, not the least of which was the excellence of the program that was offered by the President-elect and his committee, and also to the fact that for the first time the American Roentgen Ray Society had sponsored a group of round table discussions directed by many of the outstanding members of its group. These courses were very popular and Dr. Kirklin and his committee as well as those who participated in giving the courses should feel justly proud of the attendance and the interest manifested and it is to be hoped that this will become a permanent feature of the Society's annual meeting.

The scientific exhibits while excellent and of great variety fell a little short of the usual number, probably due to the fact that many of the men who would ordinarily have had exhibits were busily engaged in arranging their courses for the round table discussions. This feature should be obviated at subsequent meetings as the scientific exhibits are among the most important of the Society's activities.

The commercial exhibits were of the highest order and created a great deal of interest. The arrangements of the exhibit hall were such as to enable the scientific and commercial exhibits to be housed in one section near the entrance to the room where the scientific sessions were held. This was of great advantage and added no little to the interest which those attending the meeting took in the exhibits. The manufacturers themselves are to be thanked for their extensive exhibits and for the many new pieces of apparatus. Such exhibits always add a great deal to the success of the meeting.

The scientific program which Dr. Jenkinson and his committee had arranged was an excellent one covering a wide range in the field of medicine, both in diagnosis and therapy. The scientific sessions were held in the morning permitting the afternoons to be devoted entirely to the round table discussions.

The Chicago Roentgen Society and the Local Committee of Arrangements had planned many social features which added tremendously to the enjoyment of the members and guests who attended the meeting.

The Annual Golf Tournament for the Willis F. Manges Trophy was held on Monday at the Flossmoor Country Club. Much interest was shown in the Tournament and also in the dinner which was held at the Club in the evening.

On Tuesday evening the Caldwell Lecture was given by Dr. James T. Case, Professor of Radiology, Medical School, Northwestern University, Chicago. His subject was "Roentgenology of Pancreatic Disease." Dr. Case gave an exhaustive review of the observations of many investigators on the use of roentgenology in study of diseases of the pancreas, illustrating his lecture with numerous lantern slides.

On Thursday evening occurred the annual banquet which is always one of the highlights of the meeting. This had an added value this year in that for the first time the Society presented medals to its past presidents. The presentation of the medals was made very graciously by Dr.

U. V. Portmann, Chairman of the Executive Council. Since the organization of the American Roentgen Ray Society at St. Louis, Missouri, in 1900, it has had forty presidents and of this number the following were present: Henry Hulst, George E. Pfahler, Sidney Lange, James T. Case, Arthur C. Christie, William H. Stewart, Hollis E. Potter, Thomas A. Groover, Alexander H. Pirie, Edward H. Skinner, Harry M. Imboden, John T. Murphy, George W. Grier, Fred M. Hodges, Charles A. Waters, B. R. Kirklin, John W. Pierson and Edward L. Jenkinson.

Also at the banquet was presented to Dr. Hollis E. Potter the gold medal of the Society, the first given since the founding of the Society. This signal honor was happily bestowed. The contributions to roentgenology by Dr. Potter are too well known to need amplification. The presentation of this medal was made by the President, Dr. E. L. Jenkinson.

It was with extreme regret that the absence of some of our foreign guests was noted, particularly the President Elect of the Sixth International Congress, Dr. Herman Holthusen of Hamburg, Germany, and Dr. Ralston Paterson of Manchester, England. Just twenty-five years ago, when Dr. Sidney Lange was President of the Society, the other World War was in progress which kept the foreign guests invited at that time from attending the meeting. Dr. Lange stated in his President's Address that it was with much disappointment that he announced the fact that "The foreign guests who had promised to take part in this meeting are unable to attend . . . . The last communication that I received from Dessauer was written by him July 29 and all unawares of the impending crisis he promised to send the name of his steamer shortly and the date of his arrival in New York. A letter from Barclay two weeks ago stated that he was occupied in organizing a Red Cross Corps."

Dr. Frederick Dessauer of Frankfort, Germany, had arranged to demonstrate his new x-ray coil and tube which he claimed would produce gamma rays and Dr. A. E. Barclay of Manchester, England, was scheduled to deliver the formal evening address. Now again we are plunged into an international crisis which for a time at least will handicap the free exchange of ideas and discussions of scientific problems.

The facilities of the Palmer House are such as to permit the proper housing of the exhibits, and the arrangements of the rooms lend themselves admirably to a meeting such as ours. The Society through its Journal wishes to express its thanks to the management of the Palmer House and its capable staff for the manner in which the details of the meeting were carried out.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. C. B. Peirce, Royal Victoria Hospital, Montreal, Canada. Annual Meeting: Boston, Mass., 1940.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Next Annual Meeting: New York City, June 12, 1940.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: New City City, 1940.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Atlanta-Biltmore Hotel, Atlanta, Ga., Dec. 11–15, 1939.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets twice annually in May and September.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. W. W. Furey, 6844 Oglesby Ave., Chicago.

Radiological Section, Los Angeles Co. Med. Soc.
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. L. J. Taormina, 1093 Gates Ave., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to May inclusive at the Hotel Sherman.

Cincinnati Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. H. A. Mahrer, 10515 Carnegie Ave. Meets at 6:30 P.M. at Mid-Day Club rooms on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. E. A. Schmidt, 4200 E. 9th Ave., Denver, Colo. Meets third Tuesday of each month.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. J. N. Moore, 210 Professional Bldg., Ocala, Florida. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Illinois Radiological Society
Secretary, Dr. E. P. Halley, Decatur and Macon County Hospital, Decatur, Ill. Meetings held quarterly, time and place designated by president.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, 23 E. Ohio St., Indianapolis, Ind. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. J. C. Bell, 402 Heyburn Bldg., Louisville. Meets annually in Louisville on third Sunday afternoon in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. I. I. Cowan, Mt. Sinai Hospital, Milwaukee, Wis. Meets monthly on first Friday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets first Wednesday of each month, at 6 P.M., at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. A. O. Hampton, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. W. J. Marquis, 198 Clinton Ave, Newark. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by president.

New York Roentgen Society
Secretary, Dr. R. D. Duckworth, 170 Maple Ave., White Plains, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year—January, May, November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport, Pa. Annual meeting, June, 1940, exact time and place to be decided.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave., Meetings held second Wednesday each month, 4:30 P.M., October to June at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. S. C. Davidson, 277 Alexander St., Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

South Carolina X-Ray Society
Secretary, Dr. Hillyer Rudisill, Jr., Roper Hospital, Charleston. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg. Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. H. C. Harrell, 517 Pine St., Texarkana, Texas. Meets in Temple, Texas, Oct. 20–21, 1939.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. V. W. Archer, University Hospital, University, Va. Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday, from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. Barbara M. Key, 32 Welbeck St., London, W.1, England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to Nov. incl. for scientific discussion.

Canadian Association of Radiologists
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto, 5, Ontario.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel. Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during month of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgensellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the fall.

Societa Italiana Radiologia Medica
Secretary, M. Ponzio, University of Turin, Prof. Turin

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly on first Monday at 8 o'clock.

Polish Society of Radiology
Secretary, Dr. Jan Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6:30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

THE BUSINESS SIDE OF RADIOLOGICAL PRACTICE*

A Bulletin for Fellows and Residents in Radiology in their Final Year of Post-Graduate Training

In his preface to that valuable little book by Theodore Wiprud, "The Business Side of Medical Practice," Morris Fishbein says, "The practice of medicine involves not only the diagnosis, treatment and prevention of disease but also the simultaneous maintenance of a place in which these activities are carried on—known as an office—a system for recording those to whom the methods are applied together with the assessment of charges for the services rendered, a technic for keeping abreast of progress in the medical field, and participation in innumerable medical, public and other activities which have come to be an integral portion of the physician's life."[1]

Too often the new practitioner who has finished his medical training is apt to minimize the importance of the extra-scientific problems which arise when he begins the practical application of his professional knowledge. In relatively few schools of medicine does the student have the advantage of even a brief course of instruction in the business, sociological or legal aspects of medical practice. It is wise, therefore, for the neophyte to give serious thought to business details and socio-economic principles before beginning practice. A good start not infrequently determines the ultimate professional success of the individual.

Because the socio-economic problems currently confronting the profession of medicine are especially palpable in the case of radiology, the graduate student in radiology should take time to familiarize himself with the source and nature of some of these problems and the recommended procedures for coping with them. The book by Wiprud, mentioned above, provides a useful introduction to an understanding of the business aspects of medical practice and presents an elementary discussion of all the extra-scientific problems with which the new practitioner will be confronted. Office procedures, accounting systems and collection methods are briefly discussed. It is such items as these with which the inexperienced doctor is apt to have difficulty. Every doctor must be a bit of a business man, and, rarely having received academic training in these subjects, he should seek assistance in sound business details. A proper accounting system, adequate files and records and efficient clerical methods are essential to the conduct of a successful practice.

Legal questions pertaining to radiology, with a valuable discussion of the specialist's rights and duties in court and out, are admirably set forth in a book by S. W. Donaldson, M. D., himself a practicing radiologist.[2] It should be in the library of every radiologist when he begins his practice. A useful bibliography is included. While Donaldson's book, and others similar, contain information of interest to the radiologist, no physician should commit the error of "self-diagnosis" or "home treatment." Sufficient malpractice insurance and a good lawyer provide the only safe solutions to questions of medical jurisprudence. Modern doctrines in the law, especially in regard to alleged negligence in radiology, make it imperative that the radiologist provide himself with these protections.

Socio-economic Problems

The new practitioner of radiology enters his profession in a day when a rapidly changing social era renders obsolete much of the thinking of his professional predecessors. It is vitally important that he acquire a thorough understanding of the nature of these modern developments and their implications for medicine.

Much valuable material may be secured from the Bureau of Medical Economics of

* Bulletin of the Inter-Society Committee for Radiology.

[1] The Business Side of Medical Practice. Philadelphia: W. B. Saunders Co., 1937.

[2] The Roentgenologist in Court. Springfield, Illinois: Charles C Thomas, 1937.

the American Medical Association.[3] Every physician should avail himself of the efforts on his behalf carried on by the parent medical body. In addition to the comprehensive studies obtainable from the American Medical Association, the practicing radiologist may always look to the Inter-Society Committee for Radiology and the American College of Radiology for service and assistance. Practical solutions and valuable discussion of many of the financial problems which arise in the conduct of his practice may be found in various bulletins available at the headquarters' office. Specific questions directed to either of the above two organizations will receive the prompt attention of standing committees and a full-time staff.

There are scores of books available on the socio-economic phases of medicine, some attacking the present system of practice and some defending it. Particularly good among the latter is "Economic Problems of Medicine," by A. C. Christie, M.D., who, incidentally, is also a practicing radiologist.[4] Its bibliography will direct the reader to more extensive studies on various aspects of the broad and complex problems which complicate the present day practice of private medicine.

[3] An Introduction to Medical Economics (Revised). 112 pages
Economics and the Ethics of Medicine. 72 pages
New Forms of Medical Practice. 64 pages
Contract Practice. 24 pages.
Some Phases of Contract Practice. 32 pages.
Group Practice. 48 pages.
Medical Service Plans. 36 pages.
Organization of Medical Services. 56 pages
Medical Relations Under Workmen's Compensation (Revised). 180 pages.
Care of the Indigent Sick. 128 pages
Sickness Insurance Catechism. 16 pages
Sickness Insurance and Sickness Costs. 20 pages
Sickness Insurance Not the Remedy. 16 pages
Some Defects in Insurance Propaganda. 21 pages
Health Insurance in England and Medical Society Plans in the U. S. 20 pages
A Critical Analysis of Sickness Insurance. 96 pages
Handbook of Sickness Insurance, State Medicine and the Cost of Medical Care. 192 pages
The Radio Debate on State Medicine. 28 pages
Group Hospitalization, A Report of Experiences. 296 pages
Factual Data on Medical Economics. 67 pages.
Organized Payments for Medical Services. 185 pages.

American Medical Association, 535 North Dearborn Street, Chicago, Illinois.

[4] New York: The Macmillan Company, 1935.

Growth of Hospitals

The science of radiology grew to maturity during a period when fundamental changes were taking place in American social economy. It achieved its position as an important and indispensable specialty of medicine at a time when the entire profession was beginning to feel the effect of these modern trends. It is not strange, therefore, that the specialty of radiology should be affected by certain unwholesome conditions which owe their origin to two definite factors: The era during which the specialty was developed, and the mechanical features involved in the practical application of the science.

During the years when radiology was being advanced from a physical technique to a clinical specialty, the hospital acquired a position of new importance in the delivery of medical service. The functions of the hospital were extended in such a manner that doctors began to spend more and more of their time in the hospital. There are today over 6,000 registered hospitals in this country with a bed capacity of more than a million and a half, and new construction is going on at the rate of 100 hospital beds per day. Much of the service formerly rendered to the patient in his home is now rendered in the hospital. During this development, it was natural that radiology should come to be extensively practiced in the hospital. At the same time certain problems arose in connection with delivery of the specialist's services in the hospital.

This increase in hospitalization, plus the fact that the practice of radiology requires an initial investment of several thousand dollars for necessary equipment, is responsible for most of the peculiar problems that demand the organized attention of radiologists. Radiology is not only faced with the critical situations confronting all medicine but it has fallen heir to many difficulties of its own. Endowed with an earnest desire to protect the specialty against harmful influences

that would obstruct the continued growth and progress of its science, organized radiologists have within recent years taken certain steps and enunciated certain principles which will lead the way toward solution of some of the vexing problems affecting the practice of radiology in hospitals.

The practice of radiology is the practice of medicine, whether that practice is conducted in a hospital building or a medical office building.[5] Just as each and every step in the practice of surgery, whether it be the taking of a history, the insertion of a scalpel, or the recording of observations, constitutes the practice of surgery, so does every step, technical or interpretative, constitute the practice of radiology. The interjection of a third party into the practice of radiology interferes with the proper practice of that specialty just as it does in surgery. Radiology is a clinical specialty which frequently requires a close personal relationship between doctor and patient to insure thoroughness in examination and diagnosis. The quality of radiology is threatened when any third party assumes a dominant rôle in the delivery of radiological service to the patient. Much of radiology must be practiced in the hospital, but the hospital corporation should in no way alter the relationship between the doctor and his patient.

To be continued.

[5] *Official Proceedings of the House of Delegates, American Medical Association:* 1934, page 33.

WHEREAS, It has been reported to the officers and members of the Section on Radiology of the American Medical Association that an intolerable condition exists between certain otherwise acceptable hospitals and their departments of radiology; and

WHEREAS, It is known that in several such hospitals the business management does the collective bargaining for x-ray business with staff members and outsiders to the detriment and professional and financial loss of their staff roentgenologists; and

WHEREAS, Such practice is not only unethical but places such hospitals on a direct competitive medical practice basis with their respective roentgenologists, which practice has been declared illegal in several states; and

WHEREAS, the practice of roentgenology or radiology is ipso facto the practice of medicine and cannot be separated therefrom; be it therefore

RESOLVED, That the House of Delegates of the American Medical Association go on record as opposing the exploitation of members of their own body in the manner outlined; and be it further

RESOLVED, That the House of Delegates of the American Medical Association in session duly assembled orders this resolution to be referred to the Council on Medical Education and Hospitals for the study and formulation of plans tending to the abatement of these highly unprofessional and obnoxious evils. *Official Proceedings of the House of Delegates, American Medical Association,* 1936, Page 42.

1. It reiterates the principle enunciated by the House of Delegates at Cleveland in 1934 "That the practice of radiology, whether for diagnostic or therapeutic purposes, constitutes in fact the practice of medicine." The action of the House of Delegates in 1925 establishing a section on radiology confirms this principle.

2. It further recommends that all services connected with the practice of radiology be under the direct control and supervision of the medical profession, and this same principle pertains to other technical and professional services.

THE SCIENTIFIC EXHIBIT

Included in the Scientific Exhibit, which was an important part of the Fortieth Annual Meeting of the American Roentgen Ray Society held in Chicago, September 19–22, 1939, were twenty-three demonstrations covering various phases of roentgen diagnosis and therapy. The physical arrangements of the spacious room in which they were assembled permitted the exhibits to be shown to excellent advantage. Since great interest is always evidenced in this feature of the meeting, a brief review of the subject of each exhibit is given.

Dr. Cornelius G. Dyke, Neurological Institute, New York City, had an exhibit entitled "Pneumo-encephalography." This consisted of two parts. The first portion of the exhibit was devoted to a demonstration of the normal cerebral structures as seen in the encephalogram and ventriculogram. The various cerebral structures which border the intracranial fluid spaces were indicated. The second part was consigned to a demonstration of the various abnormal conditions affecting the intracranial contents as shown in the encephalogram and ventriculogram. Thus, demonstrations of changes in pneumo-encephalograms caused by neoplasms, infections, degenerative processes, trauma and congenital lesions were included.

"Primary Bronchogenic Carcinoma: A Pathological and Roentgenological Correlation" was the title of an exhibit by Dr. John T. Bauer and Dr. Paul A. Bishop, Departments of Pathology and Radiology,

Pennsylvania Hospital, Philadelphia. This presented a correlation of the clinical, roentgenologic and pathologic findings of a group of patients with primary cancer of the lung who came to necropsy. In most patients clinical symptoms suggested some form of pulmonary disease and roentgenograms of the chest were made; in others having trivial or no pulmonary symptoms, no roentgenograms were taken and the lesions were disclosed at necropsy. Three such cases were included since they illustrated the vague and meager symptoms which often occur in patients with cancer of the lungs. The clinical course was shown by the first chart in the series of each case. The variety of appearances observed by roentgen examination was next illustrated. The location and approximate size of the lesion was shown where the growth occurred in the parenchyma away from the main bronchi. But, more frequently, the associated pulmonary complications such as atelectasis, bronchiectasis and pleural exudate, brought about by infection or bronchial obstruction, obscure the outlines of the primary lesion. The films shown were selected as those best suited to a correlation of the roentgen and pathological findings. Sketches based upon the necropsy protocols showed the widespread extension of the disease beyond the involved lung. These indicated the approximate number, size and location of the metastases, in addition to the local primary pulmonary lesions and their peripheral pulmonary complications. Next, whenever possible, the gross appearance of the primary and metastatic lesions were shown for comparison with the roentgenograms and the postmortem findings as illustrated by the sketches. Finally, photomicrographs were displayed in order to show that the histologic appearances bear little relation to the clinical course of the disease, to the growth of the local lesion or to the extent of the metastasis. This display of a series of cases of primary cancer of the lung emphasized the necessity of early diagnosis by comparing the roentgenographic appearances of the chest with the metastatic spread. With the recent advances in thoracic surgery there is a new hope in therapy but its usefulness will be reserved for those early cases without metastasis. There were included a series of transparencies made in the case of a patient subjected to a total pneumonectomy for cancer of the lung, who is alive six months (May, 1939) after operation, to illustrate the feasibility of this procedure. The presence of metastasis to the hilar lymph nodes in this patient at the time of operation makes it probable that more peripheral extension had already occurred. This exhibit was awarded a Certificate of Merit.

Another exhibit on "Primary Carcinoma of the Lung: Bronchographic Aspects" was by Dr. Pedro L. Fariñas, Habana, Cuba. Reductions of roentgenograms and bronchograms showed the different types of bronchial carcinoma. Included were photographs of anatomical specimens corresponding to the bronchograms.

Dr. Marcy L. Sussman, Mt. Sinai Hospital, New York City, had an exhibit on "Non-putrid Pulmonary Suppuration." Serial roentgen examination reveals abscess formation in many cases of suppurative bronchopneumonia. Bronchiectases may arise and may be permanent. Pleural complications such as empyema and pyopneumothorax may occur. The exhibit consisted of roentgenograms illustrating the various stages of non-putrid suppuration and suppurative bronchopneumonia with illustrations of pathologic specimens.

"Determinations of Cardiac Size and of Cardiac Output by Roentgen Kymography" was the title of an exhibit by Dr. Ancel B. Keys, Dr. H. L. Friedell and Dr. Leo G. Rigler, University of Minnesota, Minneapolis. This presented determinations of cardiac size in systole and diastole. Measurements were shown of cardiac silhouette areas in systole and diastole and their conversion into heart volume. Systolic and diastolic heart size of selected groups (athletes and non-athletes) were presented. Correlation be-

tween cardiac output determinations from kymography and circulation rate determinations by the acetylene method were shown. This exhibit comprised numerous photographs, kymograms and charts.

An exhibit on "The Thoracic Viscera" by Dr. Carleton B. Peirce, Royal Victoria Hospital, Montreal, consisted of roentgenographic studies and diagrams of the thoracic viscera, with a suggested revised terminology for the bronchi, illustrated with clinical case material. This exhibit received a Certificate of Merit.

An exhibit entitled "Cardiac Cine-roentgenography" was presented by Dr. William H. Stewart and Dr. Charles W. Breimer, Lenox Hill Hospital, New York. This was a motion picture of the fluoroscopic image of common cardiac conditions. Among cases shown were various stages of rheumatic, syphilitic, hypertensive and arteriosclerotic heart disease. There were included several congenital heart lesions and a miscellaneous group comprising a calcified pericardium and several cases of calcified heart valves in motion.

Among the exhibits on the skeleton was included that by Dr. John Caffey on "The Nonspecificity of the Skeletal Changes in Infantile Syphilis," from Columbia University and the Babies Hospital, New York. The skeletal changes simulating skeletal syphilis from a group of 550 nonsyphilitic infants were presented. The nonsyphilitic status of these infants was established by clinical and serological studies (infants and mothers), and in some cases necropsy.

Dr. Gerard Raap, Dade County Hospital, Miami, Florida, presented the subject of "Chondrodystrophy Calcificans Congenita." Shown were roentgenograms of four cases in one family, of which two were twins, three living and one dead, with peculiar growth disturbances with calcification in cartilages of joints.

Another interesting exhibit was "Differential Diagnosis of Compression Fractures of the Spine: A Therapeutic Test" by Dr. P. A. Robin, Dr. Otho C. Hudson, Dr. N. H. Robin, and Dr. W. P. Bartels, Nassau Hospital, Mineola, New York. The object of this exhibit was an attempt to demonstrate the difficulty of differentiating between an old and recent compression fracture of the spine roentgenographically. Cases were presented in which clinically or roentgenologically the diagnosis could not be established after severe injury of the spine. The roentgenogram revealed a deformity of the body of the vertebra in each case. It has been shown that by employing acute hyperextension with an automobile jack method, all recent compression features of the vertebral bodies were partially or completely reduced. Old deformities of the vertebral bodies remained unchanged. These findings were confirmed by the clinical course of the patient and subsequent roentgenograms. This exhibit also demonstrated that healing, after complete reduction of the compression fracture, leaves no residual roentgenographic evidence of the injury.

Dr. Philip Lewin, Northwestern University Medical School, Chicago, had an extensive exhibit on the subject of "Backache and Sciatica: The Riddle of Your Backache." This consisted of illustrations and drawings of the anatomy and embryology of the spine, particularly the lumbosacral area. Many of the illustrations were in color which added to the value of the exhibit. Included was a film taken of a cross section of a cadaver showing the lumbosacrococcygeal spine and pelvis in anteroposterior and lateral projections. There was included also a group of illustrations giving the requirements for proper physical examination in lumbosacral and sciatic pains. One panel of the exhibit included the symptoms which were manifested by these patients. There were various anatomical specimens of the vertebral bodies with plaster models and drawings illustrating the intervertebral disc and its importance in low back pain. One panel contained Steindler's five postulates to prove a causal relation between local pain and radiation. The burden of the whole exhibit was to

prove that low back pain is still an orthopedic problem. There were various roentgenograms illustrating pathologic conditions in the spine. This exhibit was awarded a Certificate of Merit.

Dr. John D. Camp and Dr. E. A. Addington, Mayo Foundation, Rochester, Minn., demonstrated the "Roentgenologic Diagnosis of Intraspinal Protrusion of the Intervertebral Discs." This exhibit consisted of 72 transparencies, roentgenograms and drawings illustrating the technique for the roentgen diagnosis of protrusion of the intervertebral discs by means of iodized oil and air. The factors entering into the diagnosis by means of each procedure were shown by representative cases. Comparative studies portraying the findings revealed by the use of air and iodized oil in the same patient were shown.

Dr. W. H. Boone, Roosevelt Hospital, New York, presented the subject of "Ulcerative Colitis." This consisted of roentgenographic studies of ulcerative lesions of the colon demonstrating various stages of disease. There were included reproductions of gross lesions of the colon as seen following colectomy and comparison with preoperative films. There were also photomicrographs of pathologic material. Many of the illustrations were in color which enhanced the value of the exhibit.

An exhibit on "Ureteral Obstruction" by Dr. Bernard H. Nichols, Cleveland Clinic, Cleveland, Ohio, consisted of roentgenograms showing the different types of ureteral obstruction as established by retrograde and intravenous urography.

An exhibit entitled "Urethrography" was by Dr. S. A. Robins and Dr. M. L. Brodney, Beth Israel Hospital, Boston. This illustrated the value of urethrography in diagnosing lesions of the male urethra and adnexa. The demonstration included the normal urethra; congenital anomalies; inflammatory changes; lesions of the urethral adnexa; traumatic lesions; foreign bodies in the urethra; prostatism; neoplasms; diseases of the vesicle neck; postoperative alterations; neurological lesions; enuresis.

Dr. Webster H. Brown and Dr. A. L. Dippel, Johns Hopkins Hospital, Baltimore, presented the subject of "Localization of the Placenta: Direct and Indirect Methods." This consisted of a series of translucencies which demonstrated the method of direct visualization of the placenta and the combined use of this examination with indirect placentography in the diagnosis of placenta praevia and other obstetrical conditions. This exhibit was awarded a Certificate of Merit.

A demonstration of the "Torpin-Thoms Roentgen Pelvimeter" was given by Dr. Richard Torpin and Dr. L. P. Holmes, University of Georgia School of Medicine, Augusta, Georgia. This is a device for simplifying the Thoms method of roentgenographic pelvimetry. The device will mark and fix in space the plane of the external conjugate. A leaden plate perforated every centimeter is mechanically held in this plane and the holes are photographed on the same film with the same distortion as the superior strait; all the dimensions of the strait can thus be measured without calculation.

In the section on therapy was an exhibit on "Prevention and Treatment of Infection with the Mobile X-Ray Unit" by Dr. James F. Kelly and Dr. D. Arnold Dowell, Department of Radiology, Creighton University, Omaha, Nebraska. The authors believe that prompt response of acute fulminating types of infection to frequent small doses of roentgen radiation makes it necessary that these treatments be given without disturbing the patient. This is best accomplished with a mobile unit having adequate output. Pictures of the mobile unit were included as well as roentgenograms showing the conditions treated, such as gas gangrene, peritonitis, and surgical mumps; the technical details were also given.

In an exhibit on "Lymphoblastoma: Hodgkin's Disease and Lymphosarcoma"

by Dr. A. U. Desjardins, Mayo Clinic, Rochester, Minn., the following points were taken up: Diagnostic value of roentgen therapy; rate or regression in relatively acute and in relatively chronic cases together with prognostic significance; importance of primary or secondary involvement of the retroperitoneal nodes; significance of retroperitoneal lymphoblastoma in relation to loss of strength with or without loss of weight, and pain in the back with or without cutaneous lesions; bloating and belching after meals, sense of fullness or of weight in upper half of abdomen, inability to eat a full meal without discomfort, pain in the abdomen, etc.; bone involvement, usually from pressure by enlarging adjacent nodes (spine, pelvic bones, sternum, etc.); factors responsible in lymphoblastoma for resistance to radiation therapy—repeated excessive quantitative doses; terminal phase of disease; fibrosis associated with underlying tuberculous adenitis or with reticulum cell type; prognostic significance. Photographs, roentgenograms and charts were used to bring out these points.

Dr. E. A. Pohle and Dr. J. B. McAneny, Department of Radiology, University of Wisconsin, Madison, Wisconsin, had an exhibit on "Radium Therapy of Vascular Nevi." One hundred and fifty-two cases of vascular nevi were seen and treated in the authors' department from 1928 to 1938. This material was reviewed and the results of the statistical analysis, as well as a series of illustrations showing the lesions before and after treatment, were included in the exhibit.

An exhibit on "Roentgen-Ray and Radium Protection" by Edith H. Quimby and John Pool from the Memorial Hospital, New York City, consisted of diagrams and photographs to illustrate the various phases of the protection problem, which were supplemented by clinical case records showing the consequences of overexposure to radiation. Charts and tables furnished data regarding the protection necessary for different types of radiation at various distances from the sources. A simple method was illustrated for determining the adequacy of protection in any existing installation.

"A Radiometric Measurement of Skin Response to Actinic Radiation" was the title of an exhibit by Dr. M. L. Weinstein and Dr. Leopold Rovner, Prothero Radium Memorial, Chicago. The exhibit consisted of a demonstration of physical observation of changes in the infra-red radiation emission from the human skin accompanying erythema production. A procedure was shown for objective observation of changes in the vascular supply to the skin following its exposure to actinic radiation. By means of a thermopile radiometer, the emission of infra-red radiation from several areas of skin is measured at regular intervals prior to the irradiation of a designated area, and thereafter further measurements are systematically taken, showing the characteristic change with time of the emission from the irradiated spot in comparison with the control areas. In this way the cycle of changing events in the vascular supply of the skin, well recognized in erythema production, is continuously followed by observing the changing thermal emission from an irradiated skin area. The method operates independently of skin color and observations on white and on negroid individuals are performed with equal facility. The measurements are necessarily made under controlled atmospheric conditions of constant temperature, humidity, and rate of air flow; a portable cubicle provides the proper "observation chamber." A series of charts was presented showing some observations of the characteristic time sequences of the response of the skin to irradiation.

An exhibit on "Miniature Clinical Photography" by Dr. J. William Jones, Pottsville Hospital, Pottsville, Pa., consisted of about 90 miniature lantern slides framed and mounted on 28 (8″×10″) glass panes. Some of the transparencies were in the usual black and white, but most of them

were in color. The exhibit demonstrated that without expensive equipment, permanent records in the form of lantern slides may be made at a cost ranging from three-fourths of one cent to fourteen and a half cents. Transparencies were shown of patients with lesions of various types, as well as gross specimens, photomicrographs, and reproductions of roentgenograms.

THE COMMERCIAL EXHIBIT

The Commerical Exhibit at the Fortieth Annual Meeting of the American Roentgen Ray Society held in Chicago, Illinois, on September 19–22, 1939, was one of the largest and most attractively arranged which the Society has ever had. The size of the exhibit hall permitted the beautiful apparatus of the manufacturers to be displayed to the best advantage, and the result of much care and thought was evident in the planning and arrangement of each exhibit. Many new developments the result of patient research by capable engineers were demonstrated and great interest was evidenced by those members and guests in attendance at the meeting. The manufacturers represented in the exhibit were as follows: *Agfa Ansco Corporation*, Binghamton, New York; *Buck X-Ograph Company*, St. Louis, Missouri; *Davies, Rose and Company*, Boston, Massachusetts; *DuPont Film Manufacturing Corporation*, New York City; *Eastman Kodak Company*, Rochester, New York; *General Electric X-Ray Corporation*, Chicago, Illinois; *Kelley-Koett Manufacturing Company*, Covington, Kentucky; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Connecticut; *H. B. Odmann*, Leonia, New Jersey; *Patterson Screen Company*, Towanda, Pennsylvania; *Philips Metalix Corporation*, Mount Vernon, New York; *Picker X-Ray Corporation*, New York City; *Standard X-Ray Company*, Chicago, Illinois; *Charles C Thomas*, Springfield, Illinois; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse X-Ray Company*, Long Island City, New York.

OFFICERS ELECTED

At the recent meeting of the American Roentgen Ray Society held in Chicago, Illinois, the following officers were elected for the year 1939–1940: *President:* Dr. E. L. Jenkinson, Chicago, Ill.; *President-Elect:* Dr. Merrill C. Sosman, Boston, Mass.; *First Vice-President:* Dr. Charles L. Martin, Dallas, Tex.; *Second Vice-President:* Dr. Robert A. Arens, Chicago, Ill.; *Secretary:* Dr. Carleton B. Peirce, Montreal, P. Q. (re-elected); *Treasurer:* Dr. J. Bennett Edwards, Leonia, N. J. (re-elected); *Historian:* Dr. Percy Brown, Boston, Mass. (re-elected); *Member of the Executive Council:* Dr. Lyell C. Kinney, San Diego, Calif.

ADDITIONAL NOTICE

On page 636 of this issue will be found the outline of a course in Neurologic Roentgenology to be given at the University of Minnesota on November 13, 14 and 15, 1939. This notice was received too late for inclusion in this section.

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DEPARTMENT OF TECHNIQUE

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DETERMINATION OF THE CARDIAC AREA

SIMPLE SUBSTITUTES FOR THE 2-METER FILM, THE ORTHODIAGRAPH, AND THE PLANIMETER IN APPLICATION OF THE HODGES-EYSTER FORMULAE

By E. H. TERRILL, M.D.
WICHITA, KANSAS

THE internist should be interested in methods for accurately determining abnormalities in the size of the heart and their degree, since such changes may constitute a very important point in evaluation of the cardiac status. Cardiac hypertrophy of even a moderate degree means an abnormal heart, and not only accompanies many forms of heart disease, but may constitute almost the sole evidence of its presence.

We have all encountered instances in which the heart has been stated to be enlarged, but where better methods of measurement have proved this to be untrue. Such errors may serve to mark an individual as a victim of heart disease with its restrictions and handicaps, so any method making the determination of the size of the heart a simple office procedure, economical from the point of both time and materials, could be used to advantage.

Percussion of the cardiac outline has long been shown to be inaccurate, even in the hands of the most adept, hence the tendency to turn to the visual methods of roentgenography and roentgenoscopy, now relatively easy due to the wide distribution of the necessary apparatus.

Owing to wide variations of the cardiac outline due to habitus, attempts to recognize enlargement by the use of various linear measurements have proved disappointing. The development by Hodges and Eyster[1] of their formulae relating cardiac area in the adult to age, height, and weight, and in children to height and weight, has been a significant advance. In spite of the fact that a portion of the outline used in this method is determined more or less empirically, repeated checks of the formulae upon individuals of widely varying physical development and habitus, presenting themselves for examination for other than cardiac symptoms, and in whom no suspicion of cardiovascular disease could be found, have shown a remarkably close agreement of the measured with the predicted cardiac area.

The method, as originally described, employed a planimeter for measuring the frontal plane cardiac area from either the 2-meter film or the orthodiagram. In many well-equipped offices, the orthodiagraph and planimeter may be unavailable, and the use of the 2-meter film entails appreciable expense. It is possible, however, to achieve comparable results with a relatively insignificant outlay for material and apparatus.

The preferred method of outlining the cardiac area is by no means new. The roentgenoscopic screen is suspended so as to make its movements independent of the tube. A removable plate of thin glass is cut to fit the screen frame, and held in place by

[1] Hodges, P. C., and Eyster, J. A. E. Estimation of cardiac area in man. Am. J. Roentgenol. & Rad. Therapy, 1924, *12*, 252–265.

spring clips. The patient is placed behind the screen, asked to stand perfectly still and to hold the screen firmly against the chest. The diaphragm of the roentgenoscope is narrowed to give an illuminated area 2 or 3 cm. square. Then, as the heart outline is followed, keeping it as near the center of the illuminated square as possible, it is traced upon the glass plate with a wax pencil, this being done only during the brief intervals of full inspiration.

Areas of tracings so made upon the same individual can, with a little practice, be duplicated within 2 or 3 per cent. If preferred, the 2-meter film can be substituted with equal facility.

For determining the area, the following method has been found both simple and accurate. Place the film or glass plate carrying the cardiac outline before the illuminator, and over it a sheet of light colored, heavy wrapping paper. Trace the outline on the paper with a lead pencil. Now mark out an area within the cardiac outline about 4 × 10 cm. or 5 × 10 cm. With scissors cut out the piece whose area is to be determined, and from this cut out the measured rectangular area outlined within it. Weigh the rectangular piece of paper on a balance known to be accurate to 1 or 2 milligrams, then weigh the piece corresponding to the rest of the cardiac area. Knowing the weight of the first, and its area, the weight per square centimeter is calculated, and from the total weight, the area of the heart silhouette.

While the weight per square centimeter is fairly uniform for the same kind of paper, there is enough variation to make it desirable that the measured piece be cut from the unknown whose area is to be measured.

A balance of the required accuracy can be obtained for a moderate sum, and the arrangement of the screen requires a minimum of ingenuity. The accuracy as compared to measurements by the planimeter are all that could be desired, the difference being only 1 or 2 per cent.

Since the paper will weigh from 4 to 8 mg. per sq. cm., an error of 5 mg. can introduce a final error of only 1 to 3 per cent. It is doubtful if consistent measurements can be made by any method with a significantly higher degree of accuracy, and as the normal variations are considerably greater than this, a much higher degree of accuracy is not essential.

COMPARISON OF CARDIAC AREAS AS MEASURED BY PLANIMETER AND BY METHOD OUTLINED

Case Number	Area by Planimeter sq. cm.	Area by Weight sq. cm.
1	129.4	132.1
2	162.3	163.6
3	111.0	110.5
4	133.5	132.3
5	139.5	140.0
6	144.0	143.5
7	85.2	86.1
8	125.6	122.1
9	106.5	107.2
10	128.0	127.5
11	102.2	102.5
12	88.1	87.5
13	94.1	95.0
14	132.3	131.7
15	120.6	121.0
16	103.0	101.5
17	88.8	90.2
18	114.5	115.4
19	103.4	104.8
20	91.3	92.7

One other variation of the procedure may be of interest. In case one has available a balance reading to 1/20 gram, the tracing may be copied on the thin cardboard used in packing films. The increased weight of the material permits approximately the same degree of accuracy with the rough balance.

The method has been employed ever since the publication of the formula by Hodges and Eyster, and has proved easy, accurate, and inexpensive. The accompanying table shows the results of measurements of the cardiac area by the planimeter compared with the method outlined.

I am indebted to Dr. C. H. Warfield for the use of his planimeter for purposes of comparison.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Lindgrin, Erik. Ueber die Röntgenuntersuchung des Larynx. (Roentgen examination of the larynx.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1939, *59*, 273–285.

In 1910 Thost recommended the use of roentgen methods in the study of the larynx. Since then the study has been confined largely to views in the lateral plane. Recently Réthi and Waldapfel have used the anteroposterior projection with a small film introduced into the hypopharynx, and others have recommended tomographic methods.

The author has made a special study of the larynx with films exposed through the neck in the posteroanterior projection during different types of phonation. The function of the larynx and the changes in position of the vocal cords can thus be visualized. For the diagnosis of vocal cord paresis the films exposed in the sagittal projection are particularly suited. It is possible also to recognize infiltrations of the wall of the larynx. Pertinent cases with numerous illustrations are presented showing the possibilities of the method. Occasionally to bring out some of the finer details the method of Réthi and Waldapfel should be employed.—*W. A. Evans, Jr.*

Bauer, R., and Hauert, D. Die Röntgenuntersuchung des Schluckaktes und ihre Bedeutung für den clinischen, insbesondere den neurologischen Befund. (The roentgen examination of deglutition and its significance for the clinical and particularly the neurological study.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1939, *59*, 121–138.

The roentgen study permits an estimation of the muscles of mastication (N. trigeminus), the facial muscles (N. facialis) whose paralysis delays the progress of food in the mouth, the motility of the tongue (N. hypoglossus) as well as the innervation of the soft palate (ninth and tenth cranial nerves). Finally the rising and falling of the glottis (twelfth, but also fifth and seventh cranial nerves) may be observed. Disturbances in swallowing are recognized with greater difficulty by the patient, the farther the disturbance is from the lips. Stasis of food in the cheeks, the appearance of food in the nose, or drooling from the corners of the mouth are quickly recognized. Stasis of food in the pharyngeal pockets and abnormal movements of the glottis are less quickly appreciated by the patient and may first be recognized by the roentgenologist. Observation should be made as the patient swallows air, then a thin mixture of barium, and finally a barium paste. The stasis of barium in the pharyngeal pockets (pyriform sinuses) was described by Holzknecht and Olbert in 1910 and called "dysphagia atonica." Others have found causes in enlarged tonsils, aortic aneurysms, esophageal carcinoma, hysteria, senility, laryngeal inflammations and neoplasms, substernal thyroid, hepatic cirrhosis with eso-

phageal varices, and duodenal ulcer. Diseases of the nervous system, such as tabes, botulism, multiple sclerosis, myasthenia gravis, bulbar and pseudo-bulbar paralysis have also been reported as causes.

The author reports 14 cases. One group of neurological cases exhibited peripheral facial paralysis, pseudo-bulbar palsy, central nervous system syphilis, botulism, syringomyelia, and cerebellar tumor with pressure on the brain stem. Five cases of unilateral paralysis of the recurrent laryngeal nerve and 2 cases of bilateral paralysis (postoperative) have been studied, and in none was there a disturbance in deglutition. A study of a large group of non-neurological cases revealed only 3 in which there was a recognizable disturbance of deglutition. One was a high-situated stenosing esophageal carcinoma (other similarly situated esophageal carcinomas did not produce this effect), one was a malignant substernal thyroid mass with involvement of the esophagus, and the third was a very large upper mediastinal tumor which disappeared under roentgen irradiation.

Studies made following anesthetic applications to the pharyngeal mucous membrane in 10 individuals showed in no instance a disturbance in deglutition and in none was there retention of barium in the pyriform sinuses or aspiration into the larynx.

The differentiation of glossobuccal disturbances from those of pharyngeal origin can be made roentgenologically. The roentgen picture of an outspoken paresis of the pharyngeal muscles during deglutition, even in the absence of other signs and symptoms, indicates a pathologic process in the medulla oblongata.—*W. A. Evans, Jr.*

Dreyer, Werner. Fortschritte in der Röntgendiagnostik der Bronchialkarzinome durch Bronchographie in Verbindung mit Schichtbildverfahren and Stereoskopie. (Advances in the roentgen diagnosis of bronchial carcinoma by means of bronchography in conjunction with tomography and stereoscopy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1939, *59*, 297–315.

The authors' technique for bronchography consists in the preparation of the patient with morphine and atropine, thorough anesthesia of the pharynx, larynx and tracheal bifurcation with pantocain, the introduction of a small rubber catheter to the appropiate main bronchus, and the injection of iodized oil at room temperature. During the injection careful fluoroscopic observations are made with the patient in various positions as for gastrointestinal examinations and "spot" film studies are made at various times. Particular importance is attached to the manner in which the oil passes into the bronchial tree with the patient breathing quietly. Contraindications are tuberculosis, heart failure, hyperthyroidism, and hypersensitivity to iodine.

Seven cases are reported showing the aid given by bronchography in making the diagnosis. Most of these were bronchial carcinomas with atelectasis, one a large congenital cyst. It is recommended that stereoscopic studies be made, inasmuch as a better idea can thus be obtained of the relationship of various parts of the bronchial tree. In one instance a bronchial defect was thought to be best shown by tomography, but in general it does not seem to be a valuable diagnostic aid.—*W. A. Evans, Jr.*

Koletsky, Simon. Primary carcinoma of the lung. *Arch. Int. Med.*, October, 1938, *62*, 636–651.

Carcinoma of the lung is being recognized more and more as a frequent offender. Of 7,685 consecutive cases studied by post mortem at the Cleveland City Hospital, between 1927 and 1937, its incidence was 1.3 per cent; it represented 9.4 per cent of 1,064 cases of malignant tumor and was found to rank second only to carcinoma of the stomach as a primary type of carcinoma.

One hundred cases were studied; 35 showed small cell pattern; 40 squamous cell, 22 adeno- and 3 "carcinoma simplex." In 70 per cent of the cases, the tumor appeared to arise in or near the hilum; it spread along the mucosa or infiltrated the wall and interstitial tissues. It was found penetrating the peribronchial lymphatics, and in 11 cases it reached the pleura. In 18 cases, after occlusion, there developed bronchiectatic abscesses. All cases showed marked involvement of the tracheobronchial lymph nodes. The aorta and pulmonary vessels were frequently encased by tumor tissue. Five cases showed invasion of the superior vena cava with thrombus formation. Five cases showed a Horner's syndrome and in 3 of these there was pain in the shoulder and arm. Twenty per cent of the series (33 per cent of the small cell; 36

per cent of the adeno- and only 1 case of the squamous cell type) showed metastases to the brain. The small cell type appeared to be the most malignant. It was found in younger individuals; it grew more rapidly, extending into the posterior-superior mediastinum and into the lymphatics whereby it was widely disseminated. It appeared to be inaccessible for treatment, even early in its development. The squamous cell type appeared to offer a better prognosis, it being less infiltrating and showing little tendency to metastasize. Complete removal seemed possible, in the early stages, by pneumonectomy. The best prognosis seemed to be when the involvement was of the hyparterial bronchus in the lower lobe—from whence extension to tracheobronchial lymph nodes took place more slowly. The adeno- types metastasized more rapidly (even by way of the blood stream) than did the squamous types and therefore seemed to offer a less favorable prognosis. Roentgen therapy appeared to be of very doubtful value.

Clinically, the symptoms usually included cough with or without expectoration, thoracic pain and dyspnea. After metastases, there might be added slow speech, vomiting, pathological fractures. The total duration of symptoms from onset until death averaged about six months, in the small cell types; eight months, for the adeno- types and twelve months for the squamous cell types. Most cases described a relatively acute onset and denied antecedent pulmonary infections. Active tuberculosis was found in only 2 per cent; healed in only 5 per cent—which percentages coincide with post-mortem incidences of tuberculosis among a control group of unselected cases. Bronchoscopy was considered invaluable and should be carried out in all cases of pulmonary suppuration when the patient is over forty years of age. The roentgenological aspects are not discussed.—*A. A. de Lorimier.*

Ettinger, Alice. "Plate-like" atelectasis of the lung. *Ann. Int. Med.*, Jan., 1938, *11*, 1296–1304.

When studying roentgenograms of the chest, "horizontal stripes frequently have been mistaken for fibrinous deposits on the pleura." The author reports a case which at intervals showed such stripes, with subsequent clearings. These stripes were visualized in both the posteroanterior and lateral projections; therefore they were located in the lungs. They were found in various regions. They were first observed during the stage of reinflation after a definite atelectasis of an entire lobe. They were therefore considered to be "plate-like" atelectases "due to occlusion of small-sized bronchi." The involvement may be of so little volume of lung that the classical signs of atelectasis are not present.—*A. A. de Lorimier.*

Raia, Antoinette. Bronchiectasis in children; with special reference to prevention and early diagnosis. *Am. J. Dis. Child.*, Oct., 1938, *56*, 852–882.

The author presents a series of 33 cases in which histories showed prominent disturbances of the respiratory tract which were studied according to gradations of descending severity in order to point out the fundamental principles involved in the diagnosis, pathogenesis and prevention of bronchiectasis. The cases were divided into a group with well-established bronchiectasis, a group with minimal or early bronchiectasis and a group with potential bronchiectasis. Raia concludes that infection and obstruction seem to play the chief rôle in the production of anatomic and physiologic pulmonary damage. This damage may be of such severity as to result in acute bronchiectasis. More frequently it may result in a low grade chronic inflammation of the bronchi which renders them less resistant to subsequent bacterial invasion. Unless, at this stage, proper remedial measures are instituted, bronchial dilatations may develop. The recognition of this subacute pathologic stage, with its far-reaching possibilities, deserves particular stress, Raia believes, and has led her to describe clinically the case of potential bronchiectasis. She does not claim, however, that all cases of bronchiectasis can be eventually eliminated, for there will always occur infections that are overwhelming and there will always be pulmonary obstructions that cannot be readily removed.

In the group of well-established bronchiectasis, the roentgen findings were of varying description in two-thirds of the cases. A shadow which was persistent and localized was found most often in the lower lobes and tended to obliterate the cardiodiaphragmatic angle. In some cases persistent disseminated nodular infiltration was shown and in others pulmonary consolidation was combined with evidences of

cavitation. Slow clearing of the shadow and evidence of pleural involvement, either axillary or interlobar thickening or as a uniform density, extensive enough to obscure the underlying intrapulmonary disease were also found. Transient collapse of a lobe with subsequent reexpansion occurred in a few patients. The honeycomb appearance, sometimes described as pathognomonic of bronchiectasis, was infrequent. The outstanding roentgen findings were those of persistent pulmonary infiltration and fibrosis.

In the group which were considered cases of potential bronchiectasis, roentgen observations of patients with pneumonia revealed shadows at one or both bases of the lungs; these cleared completely in every instance, although the rate of clearing varied, being slow in some cases and rapid in others. In the intervals which were free from pneumonic exacerbations the roentgenograms in all the cases showed a definite increase in bronchial markings at the bases; this was especially prominent in the region adjacent to the right border of the heart and in the retrocardiac space as seen laterally. Numerous roentgenograms made in all cases over an extended period of observation made it possible to discount transitory changes resulting from current infections and to ascribe to each patient the degree of fibrosis which seemed most constant for each individual over a number of years. In studying the degree of fibrosis to the age incidence of pneumonia, measles and pertussis, it was found that the younger the patient when one or a combination of these illnesses occurred, the more marked was the fibrosis. Damage to the lung, as indicated by the presence of bronchial scars in the roentgenogram, does not always result, as was shown clearly by the control group.

The use of iodized poppyseed oil is of invaluable assistance in determining the exact nature of bronchial dilatation. However, the bronchogram does not reveal degrees of fibrosis or functional insufficiency of damaged mucous glands which may readily impair health. Findings with iodized poppyseed oil, Raia thinks, should therefore not be made the absolute criterion of damage to a lung or of the need for treatment. In the final analysis, the determining factor must be the functional capacity of the lung, even when anatomic changes cannot be demonstrated clinically.—*R. S. Bromer.*

Boyd, Linn J., and Werblow, S. Charles. Coarctation of the aorta, dissecting aneurysm, and aneurysmal dilatation of the left vertebral artery. *Ann. Int. Med.*, Nov., 1937, *11*, 845–850.

Only 10 per cent of the cases of aortic coarctation have been recognized ante mortem. Clinically, this diagnosis is to be considered with such evidence as hypertension (especially in the case of a young individual), marked difference in the blood pressure of the arms as compared with that of the legs. Roentgenologically, the most important criteria have been notching of the lower borders of the ribs, dilatation of the ascending aorta and tapering of the aortic arch.

Less than 5 per cent of the reported cases of dissecting aneurysm have been recognized ante mortem. Rupture through the wall of the aorta has occurred in 16 per cent of the cases of isthmus stenosis.

This combination occurred in the case reported: a housewife, aged fifty-seven, who had been stricken with an acute pain in her right abdomen and lumbar regions, precordial pain, vomiting, choking sensations and weakness. This had developed during physical activity. The blood pressure of the brachials was found to be 180/120; the popliteals were not checked. She was considered to be a case of hypertensive cardiorenal disease. The pain in the lumbar region was tentatively attributed to nephrolithiasis and morphine was given but it barely blunted the excruciating pain. The white blood cell count was 13,200 with 80 per cent polymorphonuclears. After a few hours the left radial pulse was imperceptible and there was paralysis of the muscles of the left arm, leg and face. The brachial pressure in the right arm was then 200/75. The presumptive diagnosis of dissecting aneurysm was then made. The patient died within a few more hours.

Post-mortem examination showed a hemopericardium; dissecting aneurysm of the aorta, branches of the arch and iliac arteries; coarctation of the aorta; fusiform dilatation of the terminal portion of the left vertebral artery and secondary changes. Though the Wassermann reaction had been three plus, there was no microscopical support that syphilis was responsible for the rupture. There was no notching of the lower borders of the ribs.—*A. A. de Lorimier.*

Lemke, H. H. Gibt es eine für Insuffizienz der Segelklappen typische vorhofspulsation? (Is there a typical auricular pulsation in insufficiency of the mitral valve?) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1939, *59*, 372–386.

The author is an assistant in the department of W. Böhme who has recently demonstrated the functional importance of the auriculoventricular septum in the propulsion of blood through the heart. He reports 3 cases with a marked degree of insufficiency of the mitral and tricuspid valves and great enlargement of the auricles in which expansion of the auricles was demonstrable on the kymograph coincidental with the systolic contraction of the ventricles.

This phenomenon can occur only in very advanced cases and in those where there is still a relatively powerful ventricular muscle.—*W. A. Evans, Jr.*

Stumpf, Pl. Bermerkungen zur Kritik der Kymographie des Herzens. (Critical remarks concerning kymography of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1939, *59*, 242–249.

The author defends the method against the objections of some of its critics. On the other hand, he criticizes those enthusiasts who attach too much significance to small variations in the curves which are not yet understood. There may be various causes for certain types of movement recorded in the kymogram and a correlation should always be made with the clinical and anatomical findings. Quantitative studies of the kymographic curves have little significance as there is no close correlation between the changes in the surface area as shown on the kymograph and the work of the heart. While the most important component of the curve is that due to muscle contraction, there is also an element difficult to evaluate due to the displacement and rotation of the heart as a whole. Further, as Böhme has shown, the walls of the ventricles are not as important in the emptying of the heart as the movement of the auriculoventricular septum. That the movements of the heart border do not give the key to the estimation of the general circulation is a disappointment to many, but perhaps, they, and not the kymographic technique, are at fault in having such expectations.—*W. A. Evans, Jr.*

Ludwig, Herbert. Röntgenologische Beurteilung der Herzgrösse. (Roentgen estimation of heart size.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1939, *59*, 1–52.

This is an extensive study, with a mathematical consideration of the correlation of such various orthodiagraphic heart measurements as the transverse diameter, length, area and volume with such bodily measurements as width, circumference, depth of the chest, weight and height. The conclusions are that there is little correlation between the size of the heart in the posteroanterior projection and the depth of the heart, and that serious errors are introduced by observing only one projection when the heart is of the abnormally "flat" or "deep" type. In general, a flat chest holds a flat heart, but there are exceptions, particularly when dealing with pathological enlargement.

The heart volume as well as most of the other heart measurements exhibits no correlative connection with the body height. A better correlation is obtained with the diameter and depth of the chest or the weight. The ideal heart volume which is the most valuable measurement may be estimated from the following formula; $V = 5.43g + 16.9b + 18.3t - 379$ where g is the weight, b the diameter of the thorax and t the depth of the thorax. The actual volume of the heart is computed from measurements on the posteroanterior and lateral orthodiagrams according to the Rohrer-Kahlstorf formula. A measured volume which exceeds the computed volume by more than 11 per cent has an 84 per cent chance of representing a true enlargement. Numerous tables are given for the rapid estimation of the cardiac diameter, area, and volume from the body weight, chest diameter and depth.—*W. A. Evans, Jr.*

Ludwig, Herbert. Weitere Untersuchungen zur röntgenologischen Beurteilung der Herzgrösse. (Further studies on the roentgen estimation of the heart size.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1939, *59*, 139–160.

As the patient is rotated into the left anterior oblique projection, the left border of the heart passes away from the vertebral column and the degree of rotation necessary to accomplish this is an index of the size of the left ventricle. The diameter of the chest and the diameter of the heart shadows diminish as rotation occurs. The mathematical correlation of the cardiac diam-

eter and various body measurements for different degrees of rotation has been worked out. The conclusion is drawn that the orthodiagraphic measurement in the lateral plane is the most accurate single measurement for estimating the size of the heart, next comes the diameter in the posteroanterior plane, and finally the diameter in the left anterior oblique projection (45°). The use of the sum of the first two diameters is however more accurate than anything but the volume measurement according to the Rohrer-Kahlstorf formula. The "normal" value for an individual may be calculated from the formula:

$T+T_{90^\circ}=0.0688_g+0.239_b+0.492_t+6.00$;

where g is the weight, b the diameter of the chest, and t the depth of the chest.—*W. A. Evans, Jr.*

Ludwig, Herbert. Weitere Untersuchungen zur röntgenologischen Beurteilung der Herzgrösse. (Further studies on the roentgen estimation of heart size.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1939, *59*, 250–273.

This study is based on a group of 55 soldiers with teleroentgenograms in posteroanterior, lateral, and 45° left anterior oblique projections. Three sources of error are the variability of the phase of respiration, the variability of the phase of the heart action, and the slight enlargement due to the divergence of the rays. The least scattering of values is obtained when the transverse diameter of the heart shadow is correlated with the weight and the transverse diameter of the chest. The ideal value for the cardiac diameter may be computed from the formula $T=.0663_g+0.159_b+4.06$, where g and b are the weight in kilograms and chest diameter in centmeters respectively. As with the orthodiagrams a closer correlation is obtained with the sum of the two transverse diameters of the heart when the formula becomes $T+T_{90^\circ}=0.585_g+0.294_b+0.397_t+6.01$. The volume may be computed from the formula $V=56(T+T_{90^\circ})-700$. The use of the diameter obtained from the left anterior oblique projection is less reliable. In general, the values obtained from orthodiagrams are more significant and give better correlations than those obtained from teleroentgenograms but the differences are not often great.

Attempts to correlate the relative size of the heart with various groupings of the individuals according to constitutional types were not successful.—*W. A. Evans, Jr.*

Gagelmann, Franz. Die Sequestrierung anthrakotischer and versteinter Bifurkationslymphknoten mit Bronchus- und Ösophagusfistel als umschriebenes Krankheitsbild. (The sequestration of anthracotic calcified lymph glands at the tracheal bifurcation with bronchial and esophageal fistulae as a clinical entity.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1939, *59*, 217–233.

Five cases of this condition are reported by the author from a pathological institute in Berlin. One patient suffered progressively productive cough and pulmonary gangrene with a fistula connecting the right main bronchus and a lymph gland cavity. Another in addition to cough experienced a sensation in swallowing and at autopsy there was demonstrated a fistulous communication between the esophagus and the tracheal bifurcation in addition to an abscess in the left lower lobe. A third case exhibited three diverticula of the esophagus with fistulous openings in the region of the tracheal bifurcation leading to calcified lymph glands, and there was an extensive bilateral pulmonary tuberculosis. The fourth case was found to have two perforating diverticula of the esophagus and an anthracotic stone lying in an abscess cavity near the tracheal bifurcation and there were multiple abscess cavities of the right lower lobe associated with bronchiectasis. The fifth case presented gangrenous cavitation of the right middle lobe connected by a fistulous tract to a purulent lymph node containing anthracotic pigmentation. Thus, all cases exhibited a purulent degeneration of anthracotic lymph glands near the tracheal bifurcation, infiltration of the right lower lung field with abscesses or gangrene, and fistulae either bronchial or esophageal. All but one of the patients were elderly, their ages being between forty-six and seventy-three, and an erroneous clinical diagnosis of bronchial carcinoma was common. A long history of cough and dyspnea is the rule.

Whether the fistulous tract is directed from the bronchus or esophagus to the lymph node or vice versa and whether the purulent degeneration of the lymph node is secondary to the pulmonary suppuration or vice versa are matters of dispute.—*W. A. Evans, Jr.*

Keefer, Chester S. Acute and chronic mediastinitis. *Arch. Int. Med.*, July, 1938, *62*, 109–136.

The author has studied 60 cases of acute or

chronic mediastinitis with particular interest as to cause and region of involvement.

Roentgenologically, there may be noted unilateral or bilateral triangular densities, superimposed upon the cardiac shadow, or in the superior mediastinal region. There may be evidence of empyema or extrapleural abscess. There may be displacement of the esophagus (hence the importance of a swallowing function test). There may be evidence of displacement of the trachea (not usual) or of compression of it or of the bronchi with resultant pulmonary atelectasis. There may be lesions in the spine or sternum. With mediastinal pleural effusion (which is usually unilateral) the heart may be found to be displaced.

Diagnosis depends upon history, symptoms and signs, familiarity with the paths of extension and the roentgenographic findings.

In 8 of the cases, the anterior mediastinum was involved. Extension of infections had taken place from the neck, larynx, sternum, lymph nodes or lung. Some of these localizations have developed following injury, such as fracture of the sternum, or complicating superficial infection, such as erysipelas. Most of the chronic cases are due to tuberculosis with extension from the lymphatics. Chronic diffuse mediastinitis may arise in the same way but is usually due to tuberculosis, syphilis, mycotic infection (actinomycosis or streptotrichosis), rheumatic fever, pyogenic infection, pneumoconiosis or chronic paragonimiasis. In the author's series, abscess of the posterior mediastinum was more frequent than of the anterior. The commonest causes were perforation of the esophagus, suppuration of lymph nodes or extensions of infection from the pharynx or from the spine; rarely, from the lungs, pleura or abdominal cavity. These abscesses may become especially large with very little pressure evidence and they may rupture into the trachea, bronchi, esophagus or pleural cavities.

Representative cases are cited.—*A. A. de Lorimier.*

ABDOMEN

Wilbur, Dwight L., and Mills, John H. How accurate is the diagnosis of functional indigestion? *Ann. Int. Med.*, Dec., 1938, *12*, 821–829.

The authors have reviewed the records of 354 patients of the Mayo Clinic who were diagnosed as cases of "functional dyspepsia" and who were subsequently studied, after an average interval of seven years. Even the second studies failed to reveal evidence of organic pathology in 85.6 per cent of the cases. Thirty-nine of the cases (11 per cent) were found to have such lesions as duodenal ulcer (19 cases); gastric ulcer (5 cases); disease of the gallbladder (10 cases); carcinoma of the stomach (2 cases); congenital short esophagus (1 case); diverticulosis of the colon (1 case) and chronic ulcerative colitis (1 case). Twelve patients were found to have organic disease outside of the gastrointestinal tract; pernicious anemia, heart disease; syphilis; arteriosclerosis; hyperthyroidism; myxedema; kidney stone; pulmonary tuberculosis, nephritis or pituitary tumor.—*A. A. de Lorimier.*

Abel, Walter. Zur Diagnose der Magenwandverkalkungen. (Diagnosis of calcification of the gastric wall.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1939, *59*, 57–64.

The case of a thirty-year-old woman, a native of Brazil, is presented. For two years she had suffered indigestion which was thought to be of nervous origin. Weakness, anorexia, and anemia supervened. Worms were suspected and two courses of carbon tetrachloride were tried without relief. She became pregnant and was delivered of a healthy child about nine months after the onset of symptoms. The symptoms continued after delivery in spite of all medication and relaxation. She was then brought to Germany for diagnosis and treatment. Following the removal of 4,500 cc. of ascitic fluid, a hard tumor was palpable in the left upper quadrant of the abdomen and the diagnosis of gastric carcinoma entertained. Fluoroscopically there was observed to be calcification of the stomach extending from cardia to pylorus. The deposits were greatest on the greater curvature and at the cardiac end. Barium passed rapidly through the stomach without any delay at the pylorus. No peristaltic activity was demonstrable in the stomach. Possible causes of such calcification are parasites, mercury bichloride poisoning, amyloidosis, tumors, linitis plastica, syphilis, calcium metastasis (Virchow), osteitis fibrosa generalista, and hypervitaminosis. Laparotomy was performed for biopsy of the stomach and a month later the patient died. The stomach at autopsy was greatly enlarged and the wall about 2 cm. thick. The mucosa was almost entirely destroyed. Microscopically there was widening of

the submucosa due to infiltration by tumor which was regarded as a scirrhous carcinoma. Only 2 similar cases have been found in the literature.—*W. A. Evans, Jr.*

McIntosh, Rustin, and Donovan, Edward J. Disturbances of rotation of the intestinal tract. *Am. J. Dis. Child.*, Jan., 1939, *57*, 116–166.

In this paper, McIntosh and Donovan discuss clinical problems which involve a single anatomic division of the alimentary tube, namely, the part derived from the midgut loop, or that portion of the bowel which is supplied by the mesenteric artery. They ignore, save as they have occurred coincidentally or are concerned secondarily with differential diagnosis, all types of congenital malformations except those that have to do with disturbances of the process of intrauterine developmental rotation and subsequent fixation of the distal portion of the duodenum, the small intestine and the proximal portion of the colon.

They first describe the normal development of the intestinal tube. The errors in development of the intestinal tube include malrotation with volvulus of the portion of intestine arising from the midgut, malrotation and nonrotation associated with symptoms of temporary duodenal obstruction not requiring operation, malrotation with pathologic fixation of the duodenum, volvulus of the portion of the intestine derived from the midgut associated with atresia of the ileum, nonrotation with movable cecum associated with attacks of nausea and vomiting, malrotation with volvulus associated with situs inversus abdominalis partialis, malrotation with hernia of the small intestine into a mesenteric pouch, reversed rotation with duodenal obstruction and malrotation causing melena in childhood. They report 19 cases, all of which are traceable to errors of intrauterine development of the midgut.

The cause of intestinal obstruction may lie in volvulus of the entire portion of intestine which arises from the midgut loop or of a large section of it, in the persistence of peritoneal bands which distort and constrict the duodenal channel or in combination of these. Symptoms are likely to occur within the first few days of life. In some instances, however, there is delay in their appearance, and in some, the symptoms may ameliorate and disappear spontaneously, only to return at a later age. McIntosh and Donovan have reason to believe that spontaneous improvement in these cases often denotes that a loose twist of the intestine has resolved itself. Such episodes may be frequently repeated and may give rise to a serious diagnostic problem. In all cases of duodenal obstruction and in those of "periodic vomiting" as well, the possibility of their causation by anomalies of intestinal rotation should be investigated by appropriate study, especially by proper use of roentgen methods of examination.

In the therapy of these anomalies, the preparation of the patient for operation by replacement of water and electrolytes lost during the preceding period of vomiting and starvation has been proved to be of special importance. Transfusions of small volume also are helpful. The use of radiopaque material for diagnostic purposes does not add materially to the operative difficulty or risk, provided care is taken to empty the stomach and the lower part of the bowel before operation.

Duodenal obstruction dominates the clinical picture, with bilious vomiting and progressive loss of weight as its cardinal symptoms. With obstruction from volvulus or from constriction of the intestinal lumen from outside by tight peritoneal bands, the degree of ileus is usually incomplete, and stools are passed.

In cases in which symptoms occur during the first few days of life, differential diagnosis includes "functional vomiting," congenital intrinsic obstruction of the alimentary tube, pyloric stenosis, intracranial lesions and parenteral or enteral infections. By the term "functional vomiting" McIntosh and Donovan mean to indicate the type of condition for which no organic cause is found and which clears up spontaneously within a few days. They have come to rely more and more on the roentgen examination to establish the diagnosis and localize the site of obstruction.—*R. S. Bromer.*

GENITOURINARY SYSTEM

Simon, O. Das Hämatom des Nierenlagers im Röntgenbild. (The roentgen picture of hematoma of the kidney bed.) *Fortschr. a.d. Geb. d. Röntgenstrahlen*, Feb., 1939, *59*, 178–181.

The first case of hemorrhage into the renal fossa was described by Wagner in 1856. The symptoms in such cases are usually acute with severe colicky pain, peritoneal irritation, collapse and secondary anemia. In the absence of acute signs differentiation from various forms

of renal enlargement and tumors may be difficult. The author reports the case of a man, aged forty, who had pain in the right kidney area for three months. A slightly tender mass was palpable in the right side of the abdomen and there was moderate hypertension and secondary anemia. Fluoroscopically there was elevation and immobility of the right diaphragm. Cystoscopic studies showed a normal urine, but there was failure of the dye to appear on the right following intravenous injection. The retrograde pyelogram showed extravasation in the region of the middle and superior calyces and displacement of the slightly dilated kidney pelvis in a lateral, cranial, and ventral direction. The barium enema revealed a caudal and ventral displacement of the hepatic flexure of the colon. A preoperative diagnosis of hypernephroma was made, but at operation there was found to be a large hematoma apparently arising from the surface of the kidney. The kidney was removed together with the hematoma, and necrotic and hemorrhagic areas were found in the renal parenchyma.

Two other cases roentgenologically studied have been reported in the literature. In one the kidney was displaced medially and in the other there was rotation of the kidney so that its axis was horizontal.—*W. A. Evans, Jr.*

SKELETAL SYSTEM

Turner, Philip. Acute infective osteomyelitis of the spine. *Brit. J. Surg.*, July, 1938, *26*, 71–85.

The author reports 12 cases with infective osteomyelitis of the spine and reviews the literature.

The disease is most common during the first three decades. A history of direct trauma to the spine is unusual. The presence of a focus of infection in the skin or throat is frequently noted. The infecting organism is nearly always the *Staphylococcus aureus*.

Usually one vertebra is involved though the disease may extend across the intervertebral disc to the adjacent vertebral bodies. In the dorsal and lumbar regions, the posterior arch and processes are more commonly attacked than the vertebral body. Invasion of the latter seems more common in the cervical spine. Sequestra are not constant and involucrum formation rarely occurs.

The shortcomings of the roentgen examination of other bones for early roentgen evidences of osteomyelitis apply to the spine. The early focus is usually small and may be easily overlooked. Destruction and vertebral collapse occur late or may be absent. Localized proliferative changes, mottling of the bone, and abnormalities of the intervertebral space are important roentgen findings.

The treatment depends upon the requirements of the individual case. Five of the author's patients presented evidences of encroachment upon the spinal canal. In such instances, accurate localization of the lesion, adequate decompression, and drainage are essential. Paravertebral abscesses require incision and drainage.

The mortality of acute osteomyelitis of the spine is not easy to estimate. Many cases remain undiagnosed. In hyperacute cases, death may occur in a few days. The prognosis is less favorable when the abscesses point anteriorly into the abdomen, mediastinum, or retropharyngeal space than when the lesions occupy the posterior half of the vertebral body and point into the soft tissues of the back.—*Philip J. Hodes.*

Leedham-Green, J. C., Bromley, J. F., and Raban, John. Plasmocytoma of the innominate bone. *Brit. J. Surg.*, July, 1938, *26*, 90–94.

The author calls attention to the comparative rarity of solitary myeloma and briefly reviews the literature.

Two patients with verified plasmocytomas are reported. Both patients received high voltage radiation (200 kv.), approximately 4,000 to 5,000 r being delivered into the tumor area in a period of two to four weeks. One patient is living and well two and a half years. The second, followed only six months, is also well.—*Philip J. Hodes.*

Burrows, H. Jackson. Developmental abbreviation of terminal phalanges. *Brit. J. Radiol.*, March, 1938, *11*, 165–176.

Three instances are described of developmental abbreviation of the terminal phalanx of the thumb, the condition being familial in two. The first patient shows, in addition, shortening of the terminal phalanx of both second and both third fingers, and left fourth finger, and both first toes, although affected members of her family show only the more limited and typical condition. One hundred and eight cases

of this condition are referred to in preceding literature. The condition is associated with a tendency to premature fusion of the epiphyses of the affected phalanges, but the cause of this phenomenon is obscure. A reasonable inference would be that the abnormal shortness results from the failure of growth which must follow premature epiphyseal fusion. That the shortness is not wholly accounted for in this way is suggested by the fact that it had been present in all the patients in this report for as long as they could remember, and it had been already pronounced in one of them at the age of five years. Various considerations lead the author to the conclusion that some common factor must be responsible for both the initial shortening and the premature fusion; failure of cartilage proliferation at the epiphyseal disc might provide the mechanism.—*S. G. Henderson.*

Reischauer, F. Ermüdungs- und Übernutzungsercheinungen am Knochen. (Signs of fatigue and overwork in bones.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, October, 1938, *58*, 343–365.

The author brings the concept of fatigue as it is known in metallurgy to the study of certain disturbances in bone. He uses the term "Dauerbruch" which may be translated "chronic fracture" and finds examples in a type of transverse fracture which occurs in long bones particularly when there is an osteoporosis, in fractures of the metatarsals which occur in soldiers after long forced marches or less commonly in the os calcis, tibia, fibula, femur and pubic bones, some types of spondylolisthesis when there is fracture of the laminae from chronic back strain and in pathologic fractures when there is a strain on the bone structure as the result of deformity associated with a disease process. As further example of this type of process he mentions the separation of bone fragments in osteochondritis dissecans and the avulsion of the tibial tubercle in Osgood-Schlatter's disease. This type of fracture is recognized by certain sites of predilection, by the peculiar linear, transverse character of the fracture, and by the bone change and abundant periosteal reaction about the fracture line. The actual fracture is probably always preceded by an Umbauzone, or area of alteration which occurs as the result of the long-standing strain.—*W. A. Evans, Jr.*

Pohl, John F. Chondro-osteodystrophy (Morquio's disease); progressive kyphosis from congenital wedge-shaped vertebrae. *J. Bone & Joint Surg.*, Jan., 1939, *21*, 187–192.

Morquio in 1929 published a description of a familial form of generalized osseous dystrophy, with his observations. Subsequent writers have affixed his name to the disease which he described. Briefly, the condition is a disturbance of development of the osseous system, congenital in origin, but the symptoms as a rule are not obvious at birth, or for some time afterward. When the child assumes an upright posture, the appearance of a distinct kyphosis of the spine, usually at the level of the thoracolumbar junction is first noticed. This is due to wedge-shaped malformation of the bodies of one or more vertebrae. Pain and muscle spasm which accompany tuberculous arthritis of the spine are not present, and disclosure of lesions in other parts of the skeleton eventually leads to a correct diagnosis.

General development is, as a rule, delayed but little. As development proceeds, skeletal deformities occur and advance. Prominence of the enlarged joints, knock-knee, misshapen head, and depression of the sternal portion of the chest are some of the characteristic findings. The neck is short and the head appears to sit in a concavity on top of the thorax. Roentgen examination discloses fragmentation and distortion of the epiphyses of the long bones. The condition is primarily a disturbance of the metamorphosis of cartilage into bone, but is a dysplasia rather than an aplasia. Whether or not the disease process is entitled to recognition as a distinct entity probably rests on an explanation of the fundamental cause of dyschondroplasia.

The disease is not limited to the skeletal system or to the embryonic germinal layer from which bone arises. Clouding of the cornea has been observed. The skin is often thick and inelastic. Sclerodactylia is sometimes so pronounced as to interfere seriously with the function of the fingers. The hair is often coarse and dry. In the patients observed at the Children's Hospital, Boston, accurate psychometric appraisal has shown them to be subnormal. Premature synostosis of the sutures of the skull results in malformation of the head, as well as in increasing intracranial pressure. Atrophy of optic nerves and loss of vision accompany this process, and the encephalogram in some cases

has shown an actual deficit of brain tissue.

Pohl reports a case which was reported originally in a paper from the Orthopedic Clinic of the Children's Hospital, Boston, by Dr. Thomas Wheeldon published in January, 1920, under the title: "A Study of Achondroplasia. Introducing a New Symptom—a Wedge-Shaped Vertebra." The patient was twenty-two months of age when first seen, and has now reached the age of twenty-two years, having been under continuous observation since the original communication. Pohl records the history and development of this child.—*R. S. Bromer.*

Müller, Walther. Die erbliche multiple Störung der Epiphysenverknöcherung als typisches Krankheitsbild. (Hereditary multiple disturbances of epiphyseal ossification as a clinical entity.) *Fortschr. a d. Geb. d. Röntgenstrahlen*, Jan., 1939, *59*, 65–69.

The case is described of a boy, aged twelve, who had marked flattening of both humeral and femoral heads and corresponding shallowness of the glenoid fossae and acetabula. Similar changes were present at the elbows. Irregularities of ossification were also demonstrable in the epiphyses of the metatarsals, metacarpals and their phalanges as well. The epiphyses for the lumbar vertebral bodies likewise appeared irregular and partially fragmented. Such cases have been classified by some with the chondrodystrophies but the author objects to this. Differentiation must also be made from Perthes' disease and juvenile arthritis which are quite different entities.—*W. A. Evans, Jr.*

v. Godin, Frhr. K. L. Das Röntgenbild der Marmorknochenkrankheit bei der Sektion. (The roentgen appearance of marble bone disease at autopsy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1939, *59*, 160–168.

According to Gerstel about 100 cases of this disease have been reported in the literature since the description of Albers-Schönberg in 1904. Another case is here reported of a boy, aged sixteen, with multiple pathologic fractures since the age of eight at which time the abnormal bone structure was recognized. Later there was an osteomyelitis of the mandible and optic nerve atrophy. There was no anemia until the age of fifteen when it appeared and was rapidly progressive with the cachexia until death. At autopsy extensive changes were seen throughout the skeleton and practically no bone marrow could be found. Post-mortem roentgen studies were made and reproductions of these are included in the report. Very little normal bone structure is seen and the spongiosa is replaced by compact bone of high calcium content. Broad bands occurring transversely to the axis of growth indicate the periodic and intermittent nature of the disturbance. The author attributes the long continued infection of the mandible to the poor vascularity of the bone structure and the anemia to the disappearance of the bone marrow. This latter, however, according to recent views cannot be ascribed simply to the encroachment of the thickened cortex. On the other hand, the optic nerve atrophy and the hydrocephalus are the result of purely mechanical changes.—*W. A. Evans, Jr.*

Hansen, G. Kongenitaler Femurdefekt kombiniert mit Missbildungen am Becken und Handskelett. (Congenital defect of the femur with malformations of the pelvis and hand.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1939, *59*, 172–177.

The case is reported of a boy, aged ten, whose striking abnormality was a very short left leg due to complete absence of the left thigh. Roentgenologically there was seen to be a rudimentary femur about the size of a walnut which articulated with a normally formed tibia at the level of the ischial tuberosity. An ossified patella was lacking. Other anomalies were an absence of the fifth finger and metacarpal bone on the right with only five carpal bones. On the left there was fusion of the fourth and fifth metacarpals.

By the year 1928 about 72 cases of so-called "femur defect" had been reported in the literature. Formerly many defects were ascribed to intrauterine amputation by amniotic bands, but this is now regarded as a rare occurrence. It is now believed that there is some endogenous cause probably already present in the germ plasm. However, there is very little evidence that such defects are familial or transmissible. According to present German law, sterilization is not indicated in this case, inasmuch as no other members of the family were affected.—*W. A. Evans, Jr.*

Kalbitzer, H. Beitrag zur Hand-Schüller-Christianschen Erkrankung. (Hand-Schüller-Christian's disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1939, *59*, 329–334.

The question of the relationship and nature

of the various xanthomatoses has been subject to recent study and discussions. It has not been shown with certainty whether the disturbance is purely metabolic or whether there is not a primary granulomatous formation of reticulo-endothelial cells. Some recent studies favor the latter possibility. About 170 cases of Hand-Schüller-Christian's disease have now been reported in the literature. The author reports another studied over a period of many years. The patient, a boy, was first seen at the age of five weeks with signs of pain in the right leg. An area of rarefaction was seen roentgenologically in the proximal end of the femoral diaphysis and later other lesions appeared in various parts of the skeleton. Observations were made periodically up to the eighth year of age when the skeleton showed almost complete regression of the lesions. The symptomatology of the syndrome was not complete in that there was no diabetes insipidus and no exophthalmos and apparently there was no biopsy. Healing occurred under vitamin rich diet with liver and calcium preparations and without the use of roentgen therapy. Therefore, great caution should be exercised by those evaluating the results of roentgen therapy in this disease.—*W. A. Evans, Jr.*

Müller, Walther. Beobachtungen über die Rolle der Pfannenveränderung bei der Perthesschen Krankheit. (Observations on the rôle of acetabular changes in Perthes' disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1939, *59*, 386–391.

The cause of the necrosis of the femoral head in this disease is not understood. While most observers believe the disease to be primary in the femoral head, some believe that the changes in the head are secondary to a primary disturbance in the acetabulum. A few cases of bilateral Perthes' disease have been reported in which one side was affected following the other. The author reports such an instance in the case of a boy aged fifteen. At the age of eight and a half years a typical Perthes' disease was recognized at the left hip. At this time there was a normal appearance of the right hip. Four and one-half years later the right acetabulum was observed to be flattened although no definite changes had appeared in the femoral head. Further study one year later revealed the typical changes of Perthes' disease in the right femoral head. These observations support the views of Calot and Jansen that coxa plana is the cause of Perthes' disease. The author has, however, observed many cases of Perthes' disease in which there was no flattening of the acetabulum and others in which the changes in the acetabulum were clearly secondary to the deformity of the femoral head. The author would regard the acetabular changes observed in his cases as concomitant phenomena rather than causal.—*W. A. Evans, Jr.*

Potts, Frank N., and Obletz, Ben E. Aseptic necrosis of head of femur following traumatic dislocation. *J. Bone & Joint Surg.*, Jan., 1939, *21*, 101–110.

The authors state that aseptic necrosis of the femur, following traumatic dislocation, is a serious disability. They report 5 cases in which clinical evidence of this complication appeared from two to five years after the initial trauma. For this reason, a traumatic dislocation should not be considered uncomplicated until at least five years after the injury. Its appearance should be looked for by means of repeated roentgenographic examinations at frequent intervals.

If the bone changes are seen early, they advocate the use of multiple drill holes into the neck and head of the femur to hasten reorganization of the necrotic head, with a minimum of arthritic change. They themselves have had no experience with this procedure, but suggest it as a conservative measure. Well-advanced cases are benefited by arthrodesis or arthroplasty, depending on the amount of destruction of the head of the femur in each case.—*R. S. Bromer.*

Wichtl, Otto. Das primäre Wirbelsarkom und seine Differentialdiagnose. (Primary sarcoma of the vertebra and its differential diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1939, *59*, 353–372.

Although this is a rare condition and only isolated case reports appear in the literature, the author reports 3 cases observed in recent years in the Franz Joseph Hospital of Vienna. The first case was a man, aged twenty-four, with progressive painful collapse of the first lumbar vertebra leading to death about one year after the onset of symptoms. At autopsy there was a large necrotic primary mass, and metastases were found in the liver, lymph

glands and stomach. The second patient, a woman, aged sixty-seven, also exhibited a destructive lesion of the first lumbar vertebral body which was very painful and there was a fatal outcome after eighteen months. No metastases were found at autopsy. The third case was a man, aged sixty-one, who had had low back pain for thirty years with a recent aggravation lasting four weeks. A destructive lesion was observed in the second lumbar vertebral body and in the right transverse process. Death occurred following the onset of edema of the legs which extended to the abdomen. At autopsy there was found a myxochondrosarcoma involving the second lumbar vertebra and the disc between the first and second bodies. The soft tissue mass had compressed the iliac veins which were completely thrombosed and there was embolism of the pulmonary artery.

The differential diagnosis concerns chiefly tuberculosis and secondary neoplastic lesions. In the former, the intervertebral disc is almost without exception involved. Metastases are most often multiple. Myeloma and hemangioma of the vertebra should be easily recognized. Echinococcosis, osteomyelitis, syphilis, Paget's disease, leukemia and lymphogranuloma are also considered.

A review of the roentgen literature discloses 18 cases and these have been tabulated.—*W. A. Evans, Jr.*

Batts, Martin, Jr. Rupture of the nucleus pulposus. *J. Bone & Joint Surg.*, Jan., 1939, *21*, 121–126.

Martin studied 50 cadavers upon whom no clinical data with reference to rupture of the nucleus pulposus had been obtained. Of the 50 spines examined, there were 10 cases (20 per cent) of protrusion of the disc into the bodies of the adjacent vertebrae; 8 cases (16 per cent) of rupture of the nucleus pulposus posteriorly into the spinal canal; and 3 cases (6 per cent) of anterior protrusion. He does not use the terms "protrusion of the disc" and "rupture of the nucleus pulposus" interchangeably. Protrusion may refer only to the annulus fibrosus, in which there is no solution of continuity. Rupture of the nucleus pulposus refers to an actual break in the annulus or the cartilage plate with extrusion of the nuclear contents.

The article is illustrated with pathological specimens showing the three types of lesions which are described in detail. Martin concludes that rupture of the nucleus pulposus is a common lesion. It may occur in any direction. As commonly referred to, it is taken to mean rupture posteriorly with protrusion into the spinal canal. Schmorl found that this posterior rupture of the nucleus pulposus existed in 15 per cent of the cadavers examined in routine autopsies. He was of the opinion that it did not cause symptoms. In comparison, Martin's small series showed rupture posteriorly in 16 per cent, with a strong probability that it was responsible for symptoms in 4 per cent of the cases studied.—*R. S. Bromer.*

Oeser, Heinz. Zum röntgenologischen Erscheinungsbild der Knochengeschwülste. (The roentgen appearance of bone tumors.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1939, *59*, 69–84.

This paper from the Radiumhemmet in Stockholm is a survey of the diagnostic problems in regard to bone lesions with a consideration of the age of the patient, site of the lesion, appearance and behavior of the lesion, and the periosteal reaction. Illustrative cases are cited with roentgenographic and microscopic reproductions. The conclusions are that osseous neoplasms have individual and variable appearances and different tendencies to osteoplastic and osteoclastic processes which are subject to external factors. The roentgen picture does not offer any pathognomonic signs for a positive diagnosis.

The roentgen examination leads only to an apparent and macroscopic diagnosis which is always subject to later developments and to the biopsy. The biopsy should always confirm or exclude a diagnosis of malignant neoplasm.—*W. A. Evans, Jr.*

Geschickter, Charles F., and Maseritz, I. H. Ewing's sarcoma. *J. Bone & Joint Surg.*, Jan., 1939, *21*, 26–39.

The paper deals with the diagnostic features of Ewing's sarcoma and is based on the study of 135 cases. The authors find that age, sex, duration of symptoms, and systemic manifestations are not conclusive findings. The tendency of Ewing's sarcoma to diminish in size under irradiation in a rapid manner provides an important diagnostic feature. The appearance of the lesion in the roentgenogram offered a com-

paratively positive means of diagnosis in more than 70 per cent of cases. Their comparative study of Ewing's sarcoma and sclerosing osteogenic sarcoma failed to reveal any serious difficulties in differential diagnosis. Osteolytic osteogenic sarcoma can usually be differentiated from Ewing's sarcoma by roentgenographic examination. Occasionally, however, this lesion exists as a circumscribed area of bone destruction with periosteal reaction and then can only be diagnosed by biopsy. The roentgenographic changes in chondrosarcoma were commonly found to resemble osteogenic sarcoma, but in several instances simulated Ewing's sarcoma or osteomyelitis. This may be a difficult problem, which can be settled only by microscopic study.

A study of the various metastatic lesions, multiple myeloma, Christian's disease, and leukemic involvement of bone, including lymphosarcoma, failed to reveal any serious possibility of error. Lymphosarcoma, metastasizing to bone, might simulate the changes in Ewing's sarcoma, but the clinical data and tendency to multiple bone involvement should be sufficient to avoid the possibility of error. Neuroblastoma was found to resemble Ewing's sarcoma clinically and microscopically. Both tumors respond to irradiation. The presence of rosettes and neurocytes are distinctive histological features of neuroblastoma, and furnish a basis for diagnosis.

The resemblance between Ewing's sarcoma and subacute and chronic osteomyelitis offers a very serious problem. The combined effects of bone destruction, periostitis, and reactive bone formation in osteomyelitis often result in roentgenographic changes which closely resemble those in Ewing's sarcoma. The latter is an invasive tumor, which tends to extend longitudinally along the shaft, invading the medullary cavity and destroying bone spicules in its course. In response to this invasion and destruction, new bone is laid down both subperiosteally and subendosteally. The tumor tissue possesses no properties of osteogenesis. The ratio of new bone formation and bone destruction is variable and inconsistent, giving rise to numerous roentgenographic pictures. The so-called onion-peel formation in Ewing's sarcoma is the result of multiple parallel rows of reactive bone separated by tumor tissue.

There are two distinct differences in the appearance of the transverse striations in the roentgenograms of occasional cases of Ewing's sarcoma and those found in sclerosing osteogenic sarcoma. The transverse striae of Ewing's sarcoma are fine, hair-like, and best described by the term "groomed whiskers," while those of sclerosing osteogenic sarcoma are coarse and do not present the "groomed whiskers" effect. The roentgenographic changes in sclerosing osteogenic sarcoma are those of a patchy sclerosis. Involvement is usually confined to a limited area of the distal portion of a shaft and gives the impression of tumor formation. This is not ordinarily true of Ewing's sarcoma, which most often involves from one-third to one-half of the shaft and commonly possesses a resemblance to osteomyelitis.

The authors discuss in detail the microscopical picture of Ewing's tumor. The paper is well illustrated both from the microscopical and roentgenological standpoints.—*R. S. Bromer.*

Shoemaker, Rosemary, and Robertson, H. E. Osteosarcoma of the bony pelvis associated with carcinoma of the urinary bladder. *J. Bone & Joint Surg.*, Jan., 1939, *21*, 169–176.

The authors report an interesting and unusual case of coexisting primary osteosarcoma of the pelvis and primary carcinoma of the urinary bladder. The bone tumor was considered originally as benign on the basis of the history, the clinical examination, and the examination of the gross specimen after operation. Rapid recurrence took place and caused much distress because of the situation and the extent of the tumor. The second primary tumor, a highly malignant and rapidly growing carcinoma of the bladder, brought about a fatal termination two weeks after the first symptoms referable to the urinary tract were noted.

The deceptive character of the osteosarcoma was unusual. As it grew rather slowly, was well localized, and possessed gross characteristics of the so-called benign osteoma, its true nature could only be discovered by careful study of sections obtained from different portions. In some of these, the atypical proliferation of the stromal elements and the irregular and anomalous formation of bony tissue clearly suggested its malignant tendencies. The tumor invaded the rectus abdominis and the vesical wall, and at least two nodules were found in the lungs which corresponded histologically to the structure of the primary tumor.

So diminished was the inhibition to the

growth and spread of the carcinoma of the bladder that the blood stream contained carcinoma cells at autopsy, and metastasis and invasion affected probably every tissue of the body, certainly the osteosarcoma, the lungs, the lymph nodes, the liver and the diaphragm. —*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

Leszler, Anton. Osteosklerotische Anämie. (Osteosclerotic anemia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1938, *58*, 559–563.

Osteosclerosis is a condition of increased bone formation which may be either periosteal, enosteal or both. There may be associated blood diseases, such as anemia, leukemia, aleukemic myelosis, or lymphadenosis. The bones become brittle and pathological fractures are common, but they heal readily. Involvement about the optic foramina leads to atrophy of the optic nerve. In the author's case the condition of the bones was discovered as a result of the great difficulty encountered in attempting a sternal marrow biopsy. The patient died as the result of uncontrollable hemorrhage, and a post-mortem roentgen study of all the bones was made. The final diagnosis was anaemia osteosclerotica.—*W. A. Evans, Jr.*

GENERAL

Spencer, Jack, and Warren, Shields. Boeck's sarcoid. *Arch. Int. Med.*, August, 1938, *62*, 285–296.

Sarcoid has been considered as a very chronic condition, showing a tendency to involvement of the skin. Particularly since the roentgenological studies of Kuznitsky and Bittorf it has been recognized to be of more or less generalized distribution; some cases showing lesions in the skeleton—especially of the hands and feet; other cases showing involvement of the lungs and possibly of other organs. Some have considered it to be a special type of tuberculosis.

The case report is of a male, aged fifty-one. He had been 1 of 6 children, three of whom had died, one of cardiac and one of "Hodgkin's"—possibly sarcoid. His initial complaints were of swellings of the distal jonts, with stiffness and pain. His liver appeared enlarged and there was a generalized lymphadenopathy. His strength weakened; he lost weight and appeared anemic. White blood cells numbered 20,000; red blood cells, 4,000,000; hemoglobin 70 per cent. Wassermann and Kahn reactions were negative but the gonococcus complement fixation test was repeatedly positive (though the patient insisted that he had never had gonorrhea). Roentgenography of the chest revealed symmetrical bilateral enlargement of hilar densities with lace-like infiltration extending peripherally. Elsewhere, roentgen studies were essentially negative. Lymphoblastoma was considered and roentgen therapy was given, with no response. He was put on a high protein diet; the joint swellings subsided. Because of other complaints, a peptic ulcer and ureteral calculus, subsequent studies were made and ten months later the chest appeared entirely normal. Joint swellings and pains again developed and when studied, two years and two months after the first study, there was found to be a recurrence of the hilar densities and infiltration of the lungs. Again the gonococcus complement fixation test gave positive reaction and again the tuberculin test was negative. High protein diet failed to gain improvement. There was some peeling of the skin of the forearms—suggesting a xeroderma. Cough persisted and became progressively worse until he developed an edema of the larynx and died, two and one-half years after the initial onset of the general disorder.

The post-mortem studies revealed sarcoid, with involvement of the bronchopulmonary tracheal, paravertebral, iliac and inguinal lymph nodes, lungs, trachea, heart, spleen, liver, thyroid gland, kidneys and skin; edema of the larynx and trachea; bilateral hydrothorax; a healed primary tuberculous complex (calcified), and duodenal and jejunal ulcers (with old gastroenterostomy). The authors mention that this is the first such case where lesions of the kidney and thyroid gland are reported.—*A. A. de Lorimier.*

Dickson, Ernest C., and Gifford, Myrnie A. Coccidioides infection (coccidioidomycosis). *Arch. Int. Med.*, Nov., 1938, *62*, 853–871.

Previous investigations have indicated that coccidioidal infections are due to a fungus and that there are two distinct cycles of development: the first, following infestation of animal tissues—in which case, a double-contoured spherule type of organism is found, this developing by endo-sporulation and release by rupture of the mother spherule; the second, when the organism grows outside of the body, in nature—where it develops a more vegetative form, as a mold-like fungus with chlamydo-

spores. The term "coccidioides" was given to the first form because when growing in animal tissues, the organism appeared to belong to the protozoan group.

Ophuls as early as 1905, believed that man and animals (cattle and sheep, in particular) contracted the disease by breathing the chlamydospores, scattered with dust through the air; he considered the lungs to be primarily involved. Most of the cases reported have been located in the San Joaquin Valley of Central California. There, it was found that it occurred at all times of the year. Three hundred and fifty-four cases were covered by a recent questionnaire. Males and females of all ages were involved. Only one case was fatal—by way of a coccidioidal meningitis.

The characteristic onset is by way of general malaise, headaches and often body achings; perhaps chest pains, tonsillitis and conjunctivitis. Fever may develop abruptly or after four or five days but seldom goes above 100 to 101° F. unless a definite bronchopneumonia develops in which case, of course, it may reach 104 or 105° F. There may be chills and sweats. Bronchial irritation usually develops with a nonproductive cough. The case might be considered to be "flu" until about the eighth to the fifteenth day when erythematous nodules or "bumps" (sometimes appearing as erythema multiforme) usually develop. The nodules are usually most numerous over the shins but they may be found over the thighs, buttocks, arms and even scalp and upper thorax. They are fiery red and tender. Within forty-eight to seventy-two hours, they begin to fade and after four or five more days, they disappear except for a brownish pigmentation which may persist for weeks. Occasionally, successive crops of these lesions may develop at intervals of three or four weeks. The fever usually subsides with the "bumps." The white count may range from normal to 15,000 but the differential count usually shows an eosinophilia—up to 8 or even 13 per cent (highest as the nodules begin to involute). Sputum analyses establish the diagnosis by revealing the fungus. Staining is not necessary; simply study of the fresh sputum with illumination cut down as for study of casts in urine. Plain spherules or spherules with endospores may be seen—they being characterized by a double-contoured capsule. Staining may distort their outlines. The fungus will grow on any laboratory media but Sabouraud's is recommended. The colonies are typical—a white fungous growth, usually developing in forty-eight to seventy-two hours but possibly requiring a week. For proof, this growth might be injected intraperitoneally into a male guinea pig. Within two or three weeks its testicles will enlarge as in glanders and after a month or six weeks there will be found extensive involvement of all organs, by sporulating and nonsporulating spherules of coccidioides. Time may be saved by injecting the culture growth directly into the testicles whereby spherules in pus may be found in from ten to fourteen days.

Roentgenologically, about the time of the development of nodules, the chest of the patient is likely to show pneumonic distribution of densities with enlargement of the hilar densities. There may be evidence of pleurisy and even of effusion.

A specific antigen may be used—"coccidioidin." This is injected intracutaneously as in the case of a Mantoux test. It is believed that sensitization develops about seven to ten days after infection; it has been found as long as ten years after the disease. A reaction during the disease may be very acute, there may be a local necrosis of the skin; therefore, only 0.1 cc. of a 1:1000 dilution should be used.

Many of these cases are likely unrecognized. Of 354 which showed the pulmonary train of symptoms, considered "valley fever," only one developed a "coccidioidal granuloma" and died. However, from 1894 to July, 1937, of 495 cases recognized as "coccidioidal granuloma," 50 per cent died. Therefore, the actual mortality rate cannot be estimated. Eight case examples are cited. The author recommends the term "coccidioidomycosis" to cover all phases and types of the disease.—*A. A. de Lorimier.*

ROENTGEN AND RADIUM THERAPY

Renton, J. Mill, Charteris, Alexander A., and Heggie, James F. Riedel's thyroiditis and its treatment by radium. *Brit. J. Surg.*, July,1938, *26*, 54–70.

Riedel's thyroiditis is not as infrequent as is commonly thought. It is a progressive disease which gradually tends to destroy the function of the gland. The disease is characterized clinically by an enlargement of the gland of peculiar iron-hard consistency attended by dysphagia, dyspnea, and dysphonia. In many instances, it is mistaken for cancer of the thyroid.

The treatment of Riedel's thyroiditis in the

past has been surgical. The authors report excellent results with radium.

Ordinarily three-fourths of the neck is encircled with a collar of radium, the radium-skin distance being 3 to 5 cm. Radium doses equivalent to 2,000 to 4,000 r filtered through 1.0 or 1.5 mm. of platinum were delivered to the skin surface in 90 to 190 hours.

Five patients treated for Riedel's thyroiditis in this fashion obtained prompt and excellent results.

The article contains an excellent review of the pathology of the disease.—*Philip J. Hodes.*

Palmer, Walter Lincoln, and Templeton, Frederic. The effect of radiation therapy on gastric secretion. *J. Am. M. Ass.*, April 15, 1939, *112*, 1429–1434.

Studies were made on patients with peptic ulcer and with the therapy of ulcer in mind. This report deals primarily with the effect on gastric secretion. Any method of depressing gastric secretion seems worthy of investigation. The potential dangers of radiation therapy have been emphasized by several investigators. However, one worker with considerable experience in radiation treatment of malignant disease is said to have found that the abdominal viscera can tolerate fairly large doses quite well.

Approximately 100 cases of peptic ulcer, including gastric, duodenal and jejunal lesions, were treated. In 88 of these the effect on the gastric secretion was studied. The amount of radiation employed consisted of ten treatments given over a period of eleven or twelve days, five treatments anteriorly and five posteriorly on alternate days through portals 15 cm. square. The portals were aimed at the upper part of the stomach. The dose of radiation through each portal was approximately 1,500 roentgens, measured without back-scatter. The roentgen formula was 200 kv., 25 ma., with 1 mm. of copper plus 1 mm. of aluminum filtration, and a focal skin distance of 50 cm., from 32 to 38 roentgens being delivered per minute. The gastric secretory response was measured by means of the standard histamine test of Bloomfield and Polland, made at variable intervals during and after therapy.

Some depression of gastric secretion was obtained in every case treated, but the extent and duration of this depression were quite variable. Complete achlorhydria to histamine was demonstrated in 35 of the 88 cases studied. The duration of the achlorhydria varied from a few days to over one year.

The most frequent complications encountered were those of the well known but poorly understood roentgen sickness. No correlation was observed between the severity of the sickness and the depression of secretion. The only serious complication encountered was in a case in whom three weeks after treatment acute pain and muscular rigidity appeared in the upper abdomen. At operation the ulcer appeared to be healed but there was a region of acute necrosis in the left lobe of the liver, presumably radiation necrosis. The abdominal wall was closed and the patient made an uneventful recovery.

Susceptibility of the gastric secretory mechanism to irradiation was found to be unrelated to age, sex, body weight or initial glandular activity.—*S. G. Henderson.*

Levitt, W. M. Regional x-ray baths in the treatment of lymphadenoma. *Brit. J. Radiol.*, March, 1938, *11*, 183–188.

From the point of view of roentgen treatment, one may divide the clinical history of lymphadenoma into three stages. First, the stage of the single recognizable lesion; second, the stage of multiple superficial lesions; and third, the stage of multiple lesions with visceral involvement and advancing cachexia. It is in the third stage of lymphadenoma that one has to face the most difficult decisions, and hitherto, when deep glands or important viscera have been extensively involved, most of the cases have been regarded as untreatable. Certain methods of wide regional irradiation have been in use at St. Bartholomew's Hospital for some ten years. If certain precautions are observed, doses of roentgen rays can be applied with ease and safety to extensive regions of the body, e.g., the whole abdomen or the whole chest, which are comparable with the doses ordinarily given to localized lesions. The method is applicable equally to the treatment of lymphadenoma, and of radiosensitive malignant neoplasms such as seminoma. For these regional irradiations, Finzi has suggested the name of "x-ray bath."

High voltage rays are used, 200 kv. with a Thoraeus filter. In all cases, four oblique fields are used, overlapping complet[illegible]. The focus-skin distance must be sufficient to cover fully the area exposed. The greatest possible care

must be taken to protect the regions not to be exposed, especially the long bones.

In the thoracic bath, lead-rubber protection is applied above the lower margin of the mandible and below the ensiform cartilage. The upper limbs are wrapped in lead-rubber. The treatment is begun with 35 surface r to one field. The fields are treated in turn day by day, and the dosage cautiously increased until the patient is taking as much as 200 r to this enormous field in a day. Blood counts are carried out about every five days, and in the absence of a contraindication, treatment is continued until a dose of 1,000 r has been applied to each field over a period of about a month. It is only when the total leukocyte count falls to 1,200, or the lymphocytes to 200, that this is regarded as a contraindication to the continuance of the treatment.

In the abdominal bath the upper limit is at the level of the ensiform cartilage, and the field is carried down to include the groin gland areas. Treatment is begun with 25 surface *r*, and may be gradually increased to about 150 surface r. The total dosage is, as in the thoracic bath, about 1,000 surface r to each field.

In the trunk bath, the field extends from the mandible down to below the groin gland areas, the limbs being very carefully protected. Treatment is begun with 20 surface r doses, and increased to as much as 125 surface r daily. Total dosage is about 600 to 750 surface r to each field. This method is not without danger.

Results with the thoracic and abdominal baths: Results are good, in the sense that superficial and deep masses in the regions treated disappear, cachexia is relieved, and the patient returns often to an apparently normal state of health and to his work. This applies not only to lymphadenoma, but also to other radiosensitive conditions, such as reticulosarcoma and seminoma. In the trunk baths, however, the most remarkable results are obtained. Of 7 consecutive cases in which trunk baths were given in 1932, 1933, and 1934, three are still alive and well, some having had intermediate treatment. One, and probably two, died as a direct result of the treatment. Five were cases of lymphadenoma; one, a seminoma; and one, a sensitive ovarian tumor.—*S. G. Henderson.*

Dörr, Hans. Knochenmetastasen nach behandeltem Uteruskarzinom. (Osseous metastases following a treated uterine carcinoma.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1938, *58*, 556–558.

The most common sites of primary tumors which produce metastases to the bone are the breast, prostate, thyroid and stomach. Such metastases, in the author's experience, are extremely rare in carcinoma of the female genitals. Sciatic pain which in a man is often due to prostatic metastasis is in the woman much more commonly associated with parametrial invasion. Two cases are reported, one with a fatal carcinoma of the uterine cervix associated with a pathological fracture of the right humerus, and the other a patient with a carcinoma of the body of the uterus for over two years and destructive metastases in both pubic bones and in the neck of the left femur together with a pathological fracture at the latter site. The author considers the possibility that the irradiation has produced the bone lesions in the latter case, but regards it as very improbable.—*W. A. Evans, Jr.*

Dennig, Helmut. The non-operative treatment of hyperthyroidism. *Ann. Int. Med.*, Feb., 1938, *11*, 1472–1478.

Because of widespread difference of opinion, regarding the relative merits of surgery versus radiation therapy, the author has analyzed his cases according to the type of treatment given.

The basal metabolism is considered to be most indicative of the state of thyroid activity; cardiac symptomatology, exophthalmos, psychic imbalance, etc., are also important. In the way of treatment, physical and mental rest are both indicated; therefore confinement to bed and soporifics may be necessary for several weeks. The diet should be rich in calories and rich in vitamins (in particular, vitamin A). If there be a diarrhea, a gastric analysis is in order and if the hydrochloric acid is low, it should be administered. Insulin and glucose may be given to antagonize the thyroid hormone. Iodine is one of the most effective medicaments. It should be given in dosages of 50 to 200 milligrams of iodine daily (depending upon the patient); the favorable effect should be seen in two or three days with a maximum in one or two weeks. After that time the effects wane and for that reason either surgery or radiation therapy might be given.

The author mentions that the number of complete cures with radiation therapy is not

as great as obtained with surgery but denial of benefit by roentgen therapy can only be the result of insufficient experience or unsatisfactory technique. Many severe cases are completely cured by it and there is practically no mortality if the combination of medical care and roentgen therapy be practised. Of course a reliable radiation therapist is essential. The author's patients were treated by the fractional method, receiving 185 r (measured in air) at each treatment, through a relatively large portal, including the thyroid and the thymus. Treatments were given at weekly or ten day intervals until five such were received. Thereafter, a rest of five weeks was allowed and then the same amount and spacing of treatments was repeated. The quality of radiation was of a half-value layer equal to 0.7 mm. copper. Surgery was advised if improvement did not follow.—*A. A. de Lorimier.*

Jones, H. W., Tocantins, L. M., and Smith, R. M. Splenic irradiation in the treatment of purpura hemorrhagica. *Ann. Int. Med.*, Jan., 1938, *11*, 1311–1331.

Various observers have expressed enthusiasm regarding benefits derived by roentgen therapy to the spleen in cases of purpura hemorrhagica. Others have refuted these ideas. Some claim the rationale of such treatmnt to be for depression of the activity of the clasmatocytes in the spleen; others say that by destruction of cells there, the reticulo-endothelial system in general is stimulated and thereby platelets are formed in greater numbers.

Mettier and others have recommended dosages of 200 to 300 r daily until 1,200 to 3,300 r are given in six to fifteen days. The authors treated 11 cases, giving 54 to 500 r and have become discouraged. They lean to consolation because of the report of Pancoast, Pendergrass and Fitz-Hugh who had given dosages of approximately 160 r without favorable response. —*A. A. de Lorimier.*

Miller, T. Grier. Rectal stenosis from roentgen therapy. *Ann. Int. Med.* Dec., 1937, *11*, 993–1000.

The author calls to the attention of internists the possibility of stenosis of the rectum developing after roentgen or radium therapy, as given for treatment of carcinoma of the prostate. He had 2 cases which he referred for such treatment and these complications developed. Detailed references to other reports of such are given. He speaks of the radiation therapy having been "intensive." A table is used to record the amounts of radiation given in the several series and also the summation dosages but there is no description of the quality of radiation nor the method of its application.—*A. A. de Lorimier.*

Aub, J. C., Evans, R. D., Gallagher, D. M., and Tibbetts, Dorothy M. Effects of treatment on radium and calcium metabolism in the human body. *Ann. Int. Med.*, Feb., 1938, *11*, 1443–1463.

Clinical investigations, dealing with 3 cases of radium assimilation, are reviewed. Two of these cases present evidence as to metabolic processes and effects incident to prolonged storage of the radium; the other, as to elimination processes immediately after assimilation of it. The first of these had received radium intravenously (for treatment of an arthritis) about ten years before admission to the hospital. Two years previous to admission, this patient had suffered with necrosis of the jaw. Tests showed that she had 15.2 micrograms of radium stored in her body. Her daily excretions (after administrations of ammonium chloride, thyroid extract and parathyroid extract) represented about 0.005 per cent of her total radium storage. This amount of excretion was only about 0.1 microgram (two-thirds of 1 per cent) more than was eliminated without therapy. Regardless of what seemed to be a poor rate of excretion, subsequent roentgenography of the mandible visualized reossifications.

The second patient was a young woman, aged thirty, who had been a dial painter from the age of sixteen. Roentgenography revealed "destructive lesions" at sites of epiphyseal unions; the head of the humerus, the head of the femur, etc. Thus there was evidence that radioactive salts have a predilection for epiphyseal areas as does lead and the thorium salts. This patient was found to have 18×10^{-6} grams of radium stored in her body. Gamma-ray measurements indicated that this was not uniformly stored (also suggested by roentgenography, as mentioned). Without treatment her excretion rate was about 0.005 per cent of the total. With low calcium diet, thyroid extract and ammonium chloride the radium excretions were increased to three or four times the control values. The radium excretions paralleled the calcium excretions until magnesium gluconate was given which caused proportionately

greater radium excretions. Subsequently high radium excretions were noted during rest periods. The authors believe that this evidence would indicate temporary storage of it in soft tissues such as the liver. Parathyroid extract was also given during certain periods but it did not seem to have any appreciable therapeutic effect in this case (even as regards blood calcium and calcium excretions). Neither was there response to activated ergosterol (in dosages as great as 750,000 international units in three days), except that there was a shift in the excretion of the calcium, from feces to urine.

The third patient was a physicist who had inhaled a small quantity of radium only seven weeks before admission into the hospital. The radium storage then was 0.6×10^{-6}—about 1/25 the radium present in the other two patients. His excretion rate, however, was at a much faster rate—1 per cent per day—supporting other observations that early excretion of radium is at a rapid rate in comparison with excretion after several years.

About 45 per cent of the radon produced by decay of the stored radium was found to be eliminated by way of the lungs. There was no appreciable change in the amounts of radon excreted by way of the expired air after mobilizing the radium by means of thyroid extract, parathyroid extract and ammonium chloride. Studies of the blood showed slightly less radium in the red blood cells than in the serum. Comparative studies of content in the blood with excretion values for the urine and for the feces indicated that "it is less difficult to get radium out of the bone and into the blood stream than it is to get radium out of the blood stream and into the excreta."

In general, radium storage in the body is analogous to lead in distribution, mode of excretion and relationship to calcium metabolism. When excretion is artificially stimulated, more than 90 per cent of the stored radium is eliminated by way of the feces. The bile was found to contain radium; hence the liver appears to be a route of its excretion. Therapy may increase the amounts of elimination four to eight fold but it does not greatly reduce the total stores of the radium.—*A. A. de Lorimier.*

MISCELLANEOUS

de Abreu, Manoel. Zwei Jahre kollektive Röntgenphotographie. (Two years of collective roentgen photography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1938, *58*, 574–587.

The author reports his experiences in Rio de Janeiro with small film photographs of the fluoroscopic image of the chest. The technique and method of examination which have been used in over 20,000 cases are described. Recently it has been possible to examine as many as 200 patients a day. In the various groups studied the incidence of tuberculosis was found to be from 1.2 per cent in typists to 6.7 per cent in bank clerks; the incidence of heart disease varied from 0 per cent in one small group of clerks to 1.7 per cent in grocers; and aortic failure (widening) ranged from 21.3 to 0.14 per cent. The author is very enthusiastic about the method and believes it of great value and significance in the investigation of large numbers of people.—*W. A. Evans, Jr.*

Hetzar, Walter. Die Röntgenstrahlenempfindlichkeit der Haut, insbesondere in Abhängigkeit von innersekretorischen Einflüssen. (Experimentelle Untersuchungen an der Rattenhaut.) (The sensitivity of the skin to roentgen radiation and its relation to endocrine influences; experimental studies on the skin of rats.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, October, 1938, *58*, 291–343.

This is in reality a monograph treating the subject of cutaneous reactions to roentgen irradiation in a comprehensive way. The sensitivity is much reduced by compression of the part during the treatment apparently as the result of temporary anemia. Conditions leading to increased blood flow increase the sensitivity to roentgen radiation. Skin which lies in close approximation to bone is less sensitive than where there is abundant subcutaneous tissue. Irritating or inflammatory processes always increase the radiosensitivity. Many have observed increased sensitivity with higher environmental temperatures. Old or cachetic individuals generally have an increased skin tolerance. Some have observed variations ascribed to dietary changes. Users of alcohol, quinine, iodine, heavy metals, etc., have decreased skin tolerance. Generalized infections (malaria, syphilis, sepsis) as well as cardiac and renal affections are associated with decreased tolerance and this has also been observed in lymphatic and myeloid leukemia and in hemolytic icterus. The asthenic, vagotonic and neuropathic individuals in general are

more sensitive to roentgen rays. Red haired blondes are particularly sensitive. The hypersensitivity of those with Basedow's disease is well recognized and the contrary is true of myxedematous persons. Some have observed a parallel between skin sensitivity and sexual activity. During pregnancy the skin is more sensitive between the third and seventh months.

Studies with skin erythema are difficult and carry errors as large as 40 per cent. The epilation effect is also not reliable. The author's studies were made on rats with a large dose (70 kv., 3 ma., 30 cm. distance, 1,950 *r*) of unfiltered roentgen rays given over 2×2 cm. fields producing an ulcerating exudative dermatitis in seven or eight days with final healing in about a month. Observations were made every two days and the reaction curve recorded. In the female, castration or the menopause was associated with increased tolerance of the skin to the roentgen rays. Castration in the male had no observable effect. Ingestion of thyroxin produced an earlier and more intense roentgen reaction and the reverse was true after extirpation of the thyroid gland. However, the presence of the thyroid hormone was associated with more rapid healing.—*W. A. Evans, Jr.*

Sweany, H. C., and Klaas, Rosalind. X-ray diffraction analysis as applied in pneumoconiosis. *J. Am. M. Ass.*, Feb. 18, 1939, *112*, 610–614.

When attention became centered on silicon dioxide as the cause of fibrosis in silicosis, it was expected that a chemical analysis for the substance would establish the presence or absence of pathologic levels in tissues and body fluids. Because a chemical analysis gives only total silica, which may occur in the tissue as free silica or in the combined form of some silicate, it is evident that a new approach to the problem was necessary in order to differentiate the harmful from the relatively harmless forms of silica. The method of Clark and Reynolds, which made use of roentgen-ray diffraction analysis in the identification of quartz in mine dusts, seemed to offer possibilities of application in the field of tissue analysis.

For roentgen study, thin samples of dry lung tissue were prepared by packing the powdered tissue into disks from 0.2 to 0.3 mm. in thickness. The roentgen beam, collimated by two 0.01 inch (0.025 cm.) pinholes, was supplied by a Philips Metalix tube with a copper target, operating at 20 ma. and 27 kv. (peak). The film was held in a flat holder at a distance of 5.0 cm. from the sample. The exposure time was usually seven hours. In the normal group roentgen-ray diffraction analysis showed no quartz lines. All the specimens for the group comprising patients with silicosis showed the 3.34 Å spacing of quartz. As the concentration of quartz increases, the 4.25 Å spacing becomes visible. An amount of quartz sufficient to produce fibrosis may be detected by roentgen-ray diffraction analysis.

In conclusion, the authors state that roentgen-ray diffraction analysis is characterized by its great specificity, the tissue can be used for the analysis unmodified by chemical treatment, and the method is one of great sensitivity, quartz being detectable in a concentration as low as 0.2 per cent. This concentration has been found in previous work to constitute the threshold of the pathologic level.—*S. G. Henderson.*

Crowther, J. A. The biological action of x-rays—A theoretical review. (Twentieth Silvanus Thompson Memorial Lecture.) *Brit. J. Radiol.*, March, 1938, *11*, 132–145.

The purpose of this paper is to discuss the stages by which the energy of the photon is transformed into biological destruction, with particular emphasis on the action of roentgen rays on single cells and unicellular organisms. There is an extraordinary difference shown by different tissues to the action of the radiation. Cells are much more susceptible during mitosis than in the resting stage, and rapidly dividing and undifferentiated cells are, in general, more susceptible than adult tissues. The lethal action of massive doses of radiation, which is nonspecific, is no doubt due to chemical changes in the cytoplasm, brought about by the large amount of energy liberated in the tissues. The effects produced by small doses of radiation fall into three categories: (1) inhibition of mitosis, (2) production of mutations, (3) in certain cases, particularly in the case of rapidly dividing cells, death. It seems probable that the effect produced is connected with some action of the radiation, specifically on the nucleus, the ultimate effect being on the gene.

The behavior of roentgen rays in absorbent material, from the physical point of view, is discussed. It is important to bear in mind that either in photoelectron absorption, or in absorption by the Compton scattering effect, the

energy available ultimately becomes concentrated in a comparatively small number of atoms. It is this fact alone which makes it possible for roentgen rays to produce any discernible effects. It is also important to realize how highly discontinuous the action of the radiation is.

Explanations of the biological action of roentgen rays fall into two main categories labeled the "poison" hypothesis and the "target" hypothesis. The poison hypothesis postulates that the radiation produces, by photochemical action on the substance of the nucleus, a certain concentration of some unspecified poisonous material which results in the changes observed. The target hypothesis assumes that action takes place whenever one of the biological structures is "hit" by the radiation. A more detailed comparison of the action of powerful chemical poisons and roentgen rays on cells throws considerable doubt on the poison hypothesis. The action of roentgen rays has been shown to be independent of the temperature at which the irradiation is carried out. Action by chemical disinfectants generally shows a rapid rise with temperature. The bactericidal effect of a chemical disinfectant increases rapidly with the concentration. The death rate of bacteria under the action of roentgen rays remains quite constant as the dosage, and therefore the concentration, of poison increases. The target theory offers a simple and rational explanation based on the known behavior of the radiation. Particles of microscopic size contained in an irradiated medium have a very fair chance of escaping the effects of the radiation owing to the wide distances which separate the points at which the energy is concentrated. The probability of a hit is proportional to the mass, m, of the particle, and to the dose in roentgens. The target theory assumes that, in certain circumstances, the radiation is capable of producing, on some sensitive part of the organism, such a drastic effect, that if the organism is hit there, the organism dies. Should the material be more resistant, so that a number of hits is necessary to produce death, it will certainly be necessary to take into account the recuperative power of the cells. It will also be necessary to take into account possible variations in the radiosensitivity of the different individuals in the assembly. The volume of the target, as calculated from the survival curves, is always much less than that of the cell itself, or even of the nucleus. It is necessary, therefore, to conclude that there are in the cell certain structures especially sensitive to the action of the radiation. Observations strongly suggest that the roentgen rays act directly on the genes, as postulated by the target theory, and not indirectly through the medium of the cytoplasm.—*S. G. Henderson.*

COURSE IN NEUROLOGIC ROENTGENOLOGY

The University of Minnesota announces that a three-day continuation course in Neurologic Roentgenology will be held at the Center for Continuation Study on November 13, 14, and 15, 1939. Enrolment will be limited to radiologists. The course will occupy the full time of those in attendance. Physicians residing outside the state of Minnesota will be accepted on the same basis as residents. The tuition is $15.00. Room and board may be obtained at the Center for an average cost of $2.75 per day. The program follows:

Monday, November 13

8:30– 9:00 Orientation—J. M. Nolte, Director of Center for Continuation Study; William A. O'Brien, Director of Department of Postgraduate Medical Education.

9:00–10:30 Anatomy of Brain, Skull, and Spine—A. T. Rasmussen, Professor of Anatomy; Leo G. Rigler, Professor of Radiology.

11:00–12:00 Pathology of Tumors of the Brain and Spinal Cord—James W. Kernohan, Professor of Pathology, Mayo Foundation.

1:30– 3:30 Normal Encephalogram and Ventriculogram—Cornelius G. Dyke, Assistant Professor of Radiology, Columbia University College of Physicians and Surgeons.

4:30– 6:00 Round Table—Intracranial Calcification—John D. Camp, Associate Professor of Radiology, Mayo Foundation; Merrill C. Sosman, Assistant Professor of Roentgenology, Harvard University Medical School; Cornelius G. Dyke.

7:30– 9:00 Symposium—Brain Tumors: Clinical Aspects—J. Charnley McKinley, Professor of Nervous and Mental Diseases; Roentgenologic Aspects—Merrill C. Sosman; Surgical Aspects—Alfred W. Adson, Professor of Surgery, Mayo Foundation.

Tuesday, November 14

8:30–10:30 The Abnormal Encephalogram and Ventriculogram—Cornelius G. Dyke.

11:00–12:00 The Normal and Abnormal Sella—John D. Camp.

1:30– 3:30 Meningiomas and Lesions of the Calvarium including Fractures—Merrill C. Sosman.

4:30– 6:00 Clinical Pathological Conference—W. T. Peyton, Associate Professor of Surgery; A. B. Baker, Assistant Professor of Nervous and Mental Diseases; Harold O. Peterson, Instructor in Radiology; Merrill C. Sosman; Cornelius G. Dyke; John D. Camp.

7:30– 9:00 Symposium—Protruded Intervertebral Discs: Clinical Neurologic Aspects—M. N. Walsh, Fellow in Neurology, Mayo Foundation; Orthopedic Aspects—Ralph K. Ghormley, Professor of Orthopedic Surgery; Roentgenologic Aspects—John D. Camp; Surgical Aspects—J. Grafton Love, Assistant Professor of Neurosurgery, Mayo Foundation.

Wednesday, November 15

8:30–10:00 Radiologic Treatment of Gliomas and Pituitary Adenomas—Merrill C. Sosman.

10:30–12:00 Platybasia; Encephalography in Spastic, Mentally Deficient, and Epileptic Children—Harold O. Peterson.

1:30– 3:30 Roentgenologic Diagnosis and Localization of Lesions Affecting the Spinal Cord—John D. Camp.

4:30– 6:00 Round Table—Film Reading and Outline of Technique—John D. Camp, Harold O. Peterson.

7:00 Dinner.

Registration information may be obtained by writing to the Center for Continuation, University of Minnesota, Minneapolis, Minnesota. Enrolment is limited.

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